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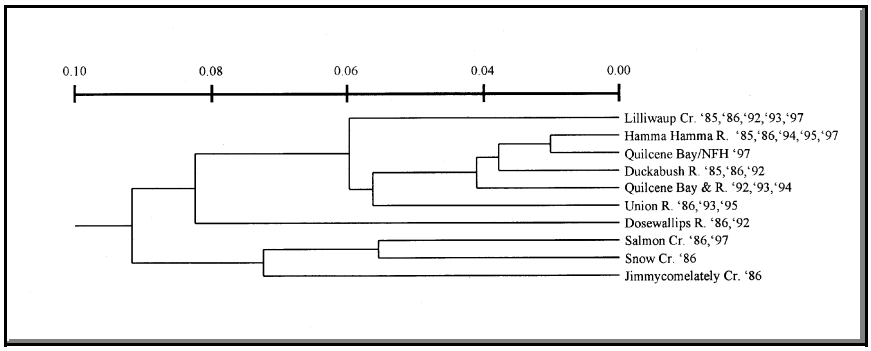

Figure 1.1. UPGMA clustering of Cavali-Sforza and Edwards (1967) chord distances among Hood Canal and Strait of Juan de Fuca summer-run chum salmon populations.

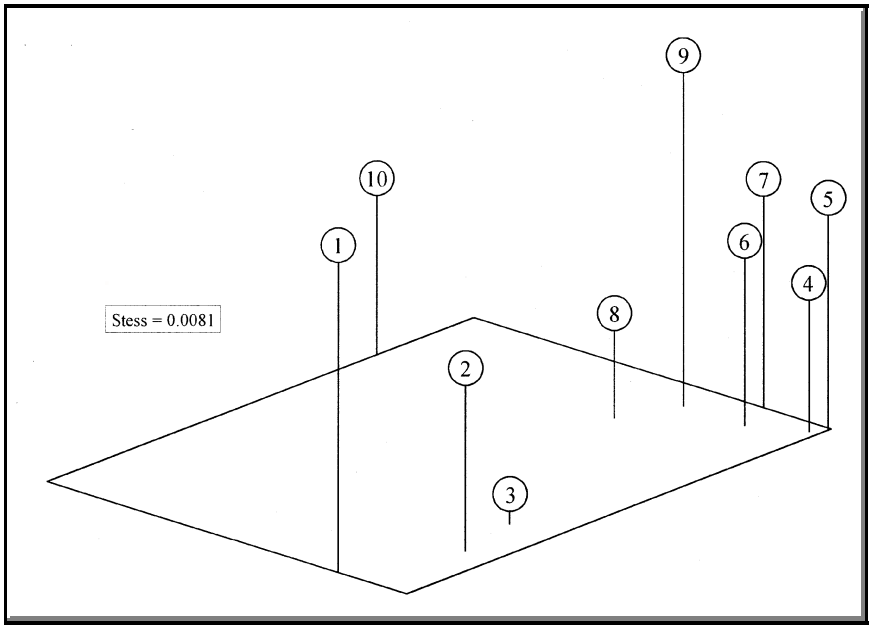

Figure 1.2. Three-dimensional scaling of genetic distances among Hood Canal and Strait of Juan de Fuca summer-run chum salmon populations. Collections are as follows: 1 = Snow Creek 1986; 2 = Salmon Creek 1986; 3 = Jimmycomelately Creek 1986; 4 = Duckabush River 1985, 1986, 1992; 5 = Quilcene Bay/National Fish Hatchery 1997; 6 = Hamma Hamma River 1985, 1986, 1994, 1995, 1997; 7 = Quilcene Bay/River 1992, 1993, 1994; 8 = Union River 1986, 1993, 1995; 9 = Lilliwaup Creek 1985, 1986, 1992, 1993, 1997; 10 = Dosewallips river 1986, 1992.

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Appendix Table 1.3. Hood Canal summer chum salmon return year age samples collected in mixed stock fisheries from 1976 to 1996 (ages for years with >100 fish sampled in bold).

Appendix Table 1.1. Summer chum salmon spawning escapement estimates in the Hood Canal and Strait of Juan de Fuca region (1968-1998).
Excluded values = missing estimates; Italicized = estimates based on regression or extrapolation.

Return Year	Jimmy Come Lately	Snow	Salmon Natural	Salmon Brdstk	Salmon Total	Big Beef	Anderson	Dewatto	Tahuya	Union	Lilliwaup	Hamma Hamma	Duckabush	Dosewallips	Big Quilcene Natural	Big Quilcene Brdstk	Big Quilcene Total	Little Quilcene
1968						100		2,275				13,548	4,693		5,797		5,797	897
1969						100		280				3,104	3,871		1,307		1,307	
1970						178	65	2,666				1,390	2,301		655		655	12
1971			249		249	159	125	2,012			318	4,282	3,904		1,798		1,798	71
1972		436	534		534	177	225	1,403	4,487		716	5,346	13,546	1,733	2,067		2,067	300
1973			636		636	244		691					5,761	623	3,107		3,107	238
1974	***438***	818	512		512	75	0	181	880	68	616	***2,448***	3,581	***3,593***	795		795	44
1975	***348***	327	755		755	1,15	195	613	1,389	***84***	706	***7,341***	2,245	***2,250***	1,405		1,405	868
1976	***365***	608	521		521	1,28	234	741	3,200	100	1,612	***7,648***	6,095	3,271	2,445		2,445	1,088
1977	***405***	538	701		701	302	***26***	225	726	75	420	***1,675***	2,453	3,215	821		821	773
1978	***778***	629	1,664		1,664	680	16	544	266	35	1,331	***8,215***	1,898	***1,901***	2,978		2,978	1,816
1979	***170***	133	458		458	191	6	49	117	***90***	163	***3,096***	1,190	***1,190***	345		345	110
1980	***1,326***	709	3,074		3,074	123	2	117	178	208	247	329	827	1,216	375		375	154
1981	***203***	242	439		439	90	1	41	140	41	293	926	557	63	138		138	84
1982	599	766	1,386		1,386	0	***0***	21	86	***153***	84	801	690	507	156		156	125
1983	254	154	731		731	0	0	15	86	170	18	190	80	64	64		64	176
1984	367	384	828		828	22	1	44	142	194	187	***170***	299	212	60		60	83
1985	61	20	151		151	0	0	19	122	334	92	***231***	30	236	44		44	1
1986	292	213	582		582	0	0	20	109	1,892	97	173	177	57	15		15	12
1987	464	465	1,062		1,062	6	0	5	91	497	32	26	12	9	8		8	71
1988	1,052	723	1,915		1,915	0	0	23	145	629	275	440	497	661	120		120	177
1989	173	21	194		194	0	0	2	9	450	43	16	60	16	1		1	1
1990	63	33	245		245	0	0	0	6	275	2	90	42	8	6		6	0
1991	125	12	172		172	0	0	31	5	208	30	68	102	250	49		49	1
1992	616	21	371	62	433	0	0	0	0	140	90	123	617	655	320	414	734	9
1993	110	11	400	52	452	0	0	1	0	251	72	69	105	105	97	50	147	12
1994	15	2	137	24	161	0	0	0	0	738	105	370	263	225	349	393	742	0
1995	223	25	538	53	591	0	0	0	0	721	79	476	825	2,787	4,029	498	4,527	54
1996	30	160	785	109	894	0	0	0	5	494	40	774	2,650	6,976	8,479	882	9,361	265
1997	61	67	724	110	834	0	0	6	0	410	10	104	475	47	7,339	657	7,996	29
1998	98	28	1,013	121	1,134	2	0	12	0	223	4	95	226	336	2,244	544	2,788	265

Appendix Table 1.2. Big Quilcene stock summer chum salmon return year ages from fish collected in Quilcene Bay fisheries and at the QNFH from 1992 to 1998.

Return Year	Number sampled	% Age-2	% Age-3	% Age-4	% Age-5
1992	210	0.0	3.3	98.6	0.0
1993	33	6.1	6.1	18.2	69.7
1994	309	1.0	91.6	6.1	1.3
1995	407	0.0	95.8	4.2	0.0
1996	481	1.9	4.0	94.2	0.0
1997	457	0.4	88.8	6.1	4.6
1998	396	0.3	65.7	33.6	0.5

Appendix Table 1.3. Hood Canal summer chum salmon return year age samples collected in mixed stock fisheries from 1974 to 1998 (ages for years with >100 fish sampled in bold).

Return Year	Sample size	% Age-3	% Age-4	% Age-5
1974	0	–	–	–
1975	0	–	–	–
1976	unknown	11.2	88.8	0.4
1977	**102**	**41.3**	**52.0**	**6.7**
1978	**285**	**51.9**	**47.7**	**0.4**
1979	**167**	**34.7**	**61.1**	**1.8**
1980	**1,201**	**59.3**	**39.9**	**0.2**
1981	**691**	**39.4**	**55.1**	**3.9**
1982	**465**	**35.9**	**61.9**	**1.9**
1983	87	65.5	31.0	3.5
1984	72	33.3	61.1	0.0
1985	**115**	**74.8**	**24.3**	**0.0**
1986	**361**	**55.1**	**42.7**	**1.7**
1987	**180**	**33.9**	**61.7**	**3.3**
1988	31	16.1	67.7	16.1
1989	18	5.8	90.5	3.6
1990	11	9.1	81.8	0.0
1991	19	26.3	68.4	5.3
1992	**203**	**3.9**	**95.6**	**0.5**
1993	58	39.1	15.9	27.5
1994	unknown	91.6	6.1	1.3
1995	0	–	–	–
1996	0	–	–	–
1997	0	–	–	–
1998	0	–	–	–

Appendix Report 1.1
Methodology For Summer Chum Salmon Escapement Estimation

Introduction

In response to the populations trends and pending ESA review processes for summer chums in the Hood Canal and Strait of Juan de Fuca regions the Washington Department of Fish and Wildlife (WDFW), and the member Tribes of the Point No Point Treaty Council (PNPTC) initiated a program in 1997 to develop a recovery plan for the summer chum populations in the region. A co-manager's summer chum restoration committee was assembled for development of the recovery plan, and proceeded to identify several data analysis needs. One of the identified needs was to re-examine the historical escapement estimations for these populations, and develop a new historical escapement database that applied consistent and well documented analytical techniques to the revised estimates.

WDFW and Washington Treaty Indian Tribes cooperatively conduct annual escapement estimation programs for many Washington salmon populations. The field data collection and analysis methods used to derive the escapement estimates are both species, and region and/or stock-specific. It is assumed that escapement estimates derived for most salmon stocks in more recent years have generally higher precision than those for earlier years because field data collection, survey effort, and data analysis methods have become more standardized, and increased knowledge and experience of the biologists conducting the estimates has resulted in more appropriate and consistent analysis of the annual field census data.

In 1997-98 revised estimates of escapement were derived for the 1968 to 1997 return years, utilizing a uniform group of analytical techniques and assumptions. An ordinal rating of the uncertainty in each estimate was also assigned, based on assessment uncertainties associated with each estimate. The same estimation approaches were subsequently applied to the 1998 summer chum escapement estimates for watersheds in the Hood Canal and Strait of Juan de Fuca region (and will continue to be used for future years).

Review of escapement estimation methodologies used for Washington chum salmon

Puget Sound salmon escapement census methods have historically included fish and/or redd counts, fishway counts, and carcass or live fish tagging and recovery (Ames 1984). Assessment of spawning escapements for management purposes were most commonly done in the time period prior to the

mid-1970s by calculation of "fish/mile" estimates derived from the peak survey counts[1] of live and dead fish in selected surveyed stream reaches (WDF 1964). Estimates of total spawning escapements of naturally spawning salmon to individual Washington streams (based on defensible quantitative methods) were rarely generated prior to the 1970s. The exceptions were for the few streams where weir or fishway count data were available, or when mark-and-recapture escapement estimation studies were performed.

In the late 1970s the "Area-Under the-Curve" (AUC) methodology was adopted for estimating escapements of many Washington pink and chum populations. This method was used by itself in smaller stream basins, or in conjunction with expansion values derived from tagging studies to derive basin-side estimates on some of the larger Puget Sound tributaries, such as the Skagit, Stillaguamish, Snohomish, and Nisqually rivers. In 1978 Washington Department of Fisheries (WDF – now WDFW) staff reviewed the historical chum survey data collected to date in the Hood Canal and southern Puget Sound regions, and derived new or revised escapement estimates for most of the major chum bearing stream basins for the time period 1968 to 1977. This process was repeated for the northern Puget Sound region in 1984. AUC has since been used as a primary escapement estimate derivation tool for most Puget Sound chum, pink, sockeye, coho, and chinook populations, where periodic live fish or spawning redd counts are the primary population data available. More detailed discussions of the AUC methodology can be found in several publications, including Ames (1984), English et al. (1992), Haymes (2000), and Lady (1996), Hilborn et al. (1999).

Given there is inter-stream and inter-annual variability in the quality of the census data collected, and that there are elements of subjectivity in application of the AUC escapement estimation method, it was determined by the members of the WDFW/PNPTC summer chum technical committee that a comprehensive review and revision of the summer chum escapement estimates was needed to provide the highest quality and most precise escapement database for the recovery planning process. An ordinal rating system (Zar 1984) for the relative quality of each individual escapement estimate was developed during the revision process, to provide users of the escapement data with an indicator of the relative quality of each estimate (good, fair, poor, etc.).

Historical monitoring of Hood Canal and Strait of Juan de Fuca summer chum escapements

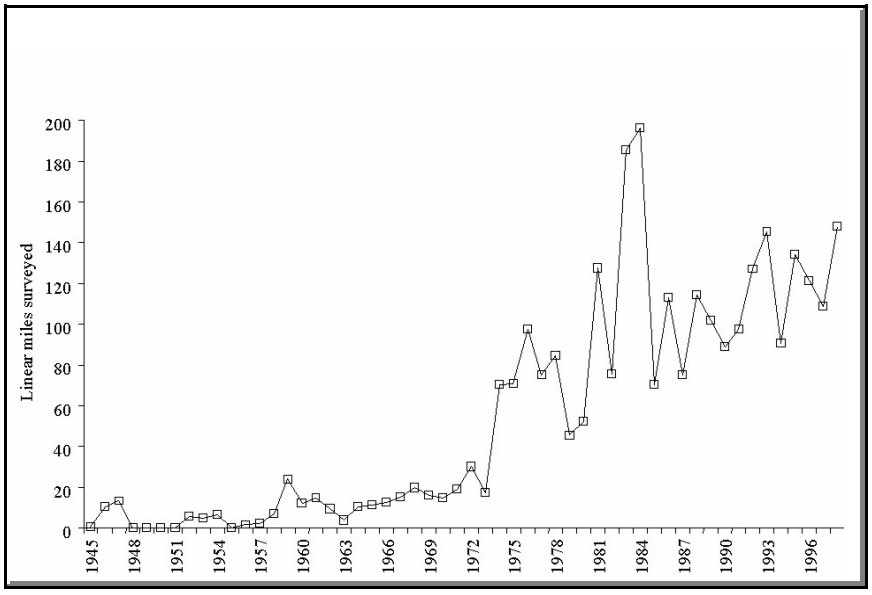
The first quantitative observations of summer chum spawning abundance recorded in the WDFW spawning survey database were collected in 1943 (J. Haymes, WDFW Olympia WA, pers. comm.). Early observation records (1943-47) were confined to the Dosewallips, Duckabush, and Hamma Hamma rivers. Information in the database for these observations is mostly limited to summaries of the total number of live and dead fish observed in the survey reach, river mile boundaries of the reach surveyed, and the date of observation. There were no Hood Canal or Strait summer chum stream observations recorded for the time period 1948 to 1950. In 1951 an "index reach" survey system was developed by WDF to monitor stream escapements of salmon in each region of

1 Which may not reflect the actual peak abundance of fish in the index reach, since annual scheduling of the peak survey was based upon professional judgement, and expectations of previous observed run timing patterns.

Washington on an annual basis (Egan 1982), and the scope of survey effort was expanded through the early 1950s time period to meet the objectives of this program. The index reaches encompassed (somewhat) fixed sections of selected streams. One to three surveys were typically conducted annually on each index reach. It is assumed that the selection of streams surveyed, sections surveyed, and timing of the survey(s) were based on review of available information and professional judgment that the survey reaches were representative of the spawning escapements of one or more salmon species to each geographic region of the state.

The Boldt Decision in 1974 prompted WDF and Washington Department of Game (WDG) to revise many of their salmon and steelhead escapement estimation techniques in the mid-1970s, due to the need for more accurate and/or precise estimates of escapements to meet new fishery management objectives and obligations. Consequently, survey effort was greatly increased in this time period. Many Treaty Indian tribes also developed or expanded fishery management programs in this time period and began to participate more extensively in spawning survey efforts.

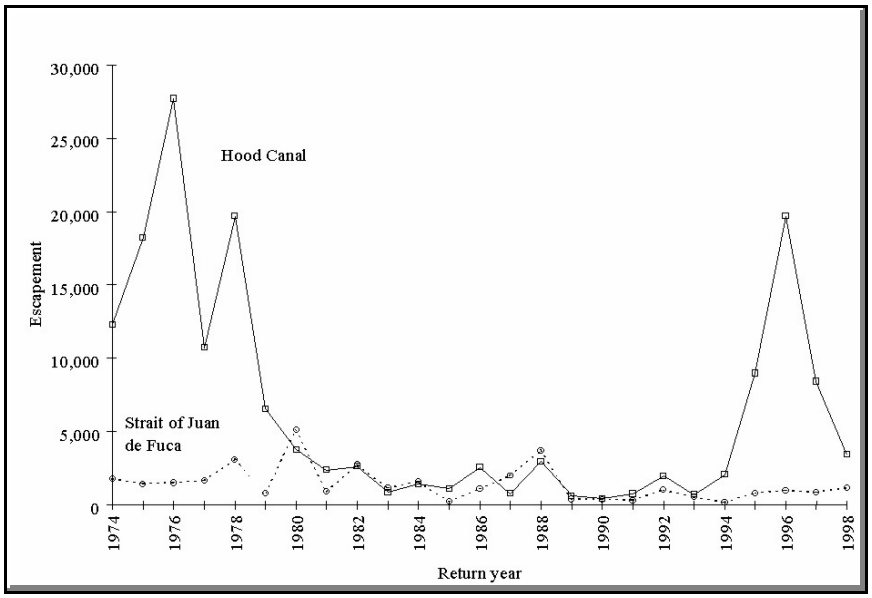
Appendix Figure 1.1.1 summarizes the historical reported annual chum spawning survey effort for summer chum streams in the Hood Canal region that have received dedicated, long-term annual summer chum survey effort for the time period 1945-98. These are Anderson Creek, Dewatto Creek, Tahuya River, Union River, Hamma Hamma River, Duckabush River, Dosewallips River, Big Quilcene River, Little Quilcene River, Snow Creek, Salmon Creek, and JimmyComeLately Creek. Only surveys conducted in the annual time period Aug. 1 to Oct. 31 are included. In general live fish counted after ~ Oct. 20 are very likely to be early returning fall chum salmon, and not used in the summer chum escapement estimates. Survey information for late October is included in the field data summary tables and charts because it is a transitional period in the streams from summer to fall chum stock entry.



Appendix Figure 1.1.1. Annual reported distance surveyed on Hood Canal and Strait of Juan de Fuca streams 1945-98.

Summary of revised escapement estimates for Hood Canal and Strait of Juan de Fuca wild summer chum populations

Appendix Figure 1.1.2 summarizes the annual aggregate natural spawning summer chum escapement estimates for the Hood Canal and Strait of Juan de Fuca regions for 1974-1998 (the 1968-1973 time period is omitted because of the limited number of individual stream escapement estimates available in this time period).

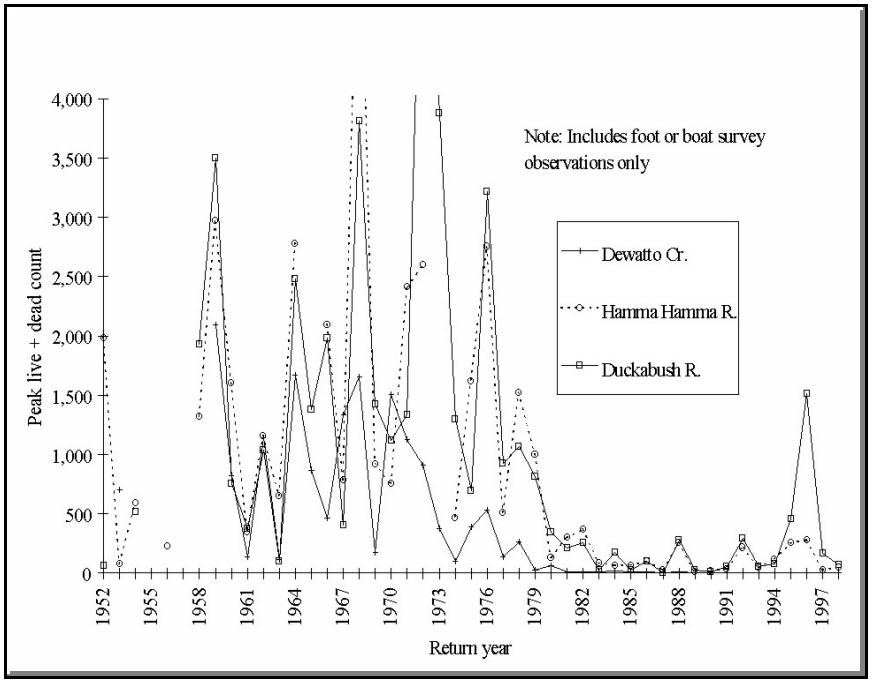


Appendix Figure 1.1.2. Hood Canal and Strait of Juan de Fuca summer chum spawning escapements, 1974-98.

In summary, a period of relatively large escapements in the Hood Canal region in the mid - 1970s was followed by a period of very poor escapements in the 1980s, a recent rebound in the 1995-96 period, and then a decline in the 1997-98 period. Unfortunately during the mid-1980s period the populations in several east shore Hood Canal tributaries become extirpated (Anderson Creek, Dewatto River, Big Beef Creek, and Tahuya River). Since this time period the majority of the total escapement for the Hood Canal region has occurred only in the west shore Hood Canal streams, with small to moderate numbers in the Union R. (100-300 fish). The Strait of Juan de Fuca streams have experienced relatively stable escapements overall. However, individual streams in this region, particularly Snow and Jimmy-Come-Lately creeks have periodically experienced extremely low escapements through this time period (< 100 fish).

For a longer term (mid-1900s to present) perspective on escapements to the Hood Canal region, Appendix Figure 1.1.3 summarizes the annual peak summer chum count (mid - September to mid - October period) for three selected Hood Canal streams that had adequate numbers of historical survey observations to facilitate a long term trend analysis (Dewatto, Hamma Hamma, and Duckabush rivers). The peak counts are not directly comparable to each other because each observation may or may not represent the absolute peak abundance for the year. Also, these values should not be rigorously compared to AUC estimates of total abundance for the years 1974 to

present, because the peak counts generally represent less than the total escapement to the stream. However, these observations do provide some indication on the relative abundance of summer chums over a longer time frame than the period formal escapement estimates have been derived. A detailed summary of the escapement estimates for each summer chum stream in the Hood Canal and SJF region, and discussions of the field data and analysis issues for each estimate are presented



Appendix Figure 1.1.3. Peak live + lead counts of summer chum in Dewatto Creek (WRIA 15.0420), Hamma Hamma River (WRIA 16.0251), and Duckabush River (WRIA 16.0351), 1952-1998.

in the report Revised Estimates of Escapement for Hood Canal and Strait of Juan de Fuca Natural Spawning Summer Chum Populations (Haymes 2000), available as Supplemental Report No. 1 to this Summer Chum Salmon Conservation Initiative.

Summer chum presence in other streams in the Region

Summer chum have been observed in several other streams in the region, generally sporadically and in small numbers. These observations were typically made during surveys targeted at other salmonid species. Most of these observations are likely the result of straying fish from other river systems, as suggested by the sporadic nature to the observations, and the small numbers of fish that were typically observed. However, review of historical records did lead to the addition of three streams to the list of watersheds in the region that appear to have contained substantial summer chum populations historically and/or currently. These are the Dungeness River, Skokomish River, and Finch Creek Insufficient data exists, however to determine historical abundance in these watersheds in detail.

The Dungeness River had sufficient observations of chum in the September/October time period to suggest that a self-sustaining population is present in the river. There are 70 historical survey

observations of chum in the Dungeness River in the annual time period Aug. 1 – Oct. 31 in the WDFW survey database (Haymes 2000). The Skokomish River historically had a summer chum run present in some years, as indicated by historical in-river commercial fishery catch data, and spawning ground data. The most significant spawning ground observation was 233 summer chum on Sept. 20, 1976 (Haymes 2000). Given 1) there are only a limited number of survey observations of summer chum in this river basin, and 2) there were a fair number of chinook surveys conducted annually in the watershed during the typical summer chum spawning period that would have noted the presence of summer chums, the runsizes generally were likely typically fairly small in the recent historical time period (1960s-present). Finch Creek historically had returns of up to several hundred summer chum in the 1950s/60s time period, as indicated by summer chum capture data at the Finch Creek (Hoodsport) hatchery rack (Tynan and Ames 1997). Both the Skokomish and Finch creeks stocks are considered currently extirpated. Status of the Dungeness stock is unknown.

There are further discussions of this subject in Haymes (2000), and in the main body of this report.

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Appendix Report 1.2
Methodology For Estimation of Summer Chum Salmon Escapement and Freshwater Entry Timing

Introduction

Knowledge of run and spawning timing behaviors for migratory fish stocks is an important tool for fisheries management, and as an indicator of adaptive differences or similarities between different populations to their environments. Typically, the migratory behavior of salmonids is tracked through the application and subsequent recovery of internal marks (binary code wire and pit tags), external marks (fin marks, external tags, freeze brands), or genetic stock identification (GSI-used to monitor for the presence of genetic traits unique to particular populations/groups of populations). Pacific salmonids that typically out-migrate at the fry stage (pinks, chums) are generally more difficult to mark with current technologies than the other species, because of their small size during the freshwater residence/out-migration phase; the time at which the mark application phase of most Pacific salmonid marking programs are conducted. Because of the difficulty of marking chum out-migrants by traditional methods, and the small runsizes and limited economic importance of the summer chum populations in the Hood Canal and Strait of Juan de Fuca region, there historically have been no significant marking or GSI analysis programs. Some limited GSI data that identify the presence of these fish in certain commercial fisheries has been collected in recent years, and the Big Quilcene Hatchery has begun to clip adipose fins of summer chum releases being produced for the supplementation program (first return of fin clipped fish to occur in 2000).

In order to develop estimates of spawning timing and migratory timing through the terminal fishery areas for selected major Hood Canal-SJF region summer chum populations, the spawning census data from each population was analyzed to determine average spawning timing, and assumptions were made from these analyses to calculate terminal marine migratory timing. Washington Department of Fish and Wildlife (WDFW) and Point No Point Treaty Council (PNPTC) staffs independently calculated spawning timing and terminal area passage timing statistics, using somewhat different approaches to analyzing the data and deriving the timing statistics. Each method makes some unique assumptions in regards to analysis of the survey data, and are discussed below.

Methods and discussion

- WDFW analysis (Jeff Haymes, WDFW)

The area-under-the-curve (AUC) escapement estimation approach used for calculating the annual spawning escapements to each stream basin (described in Appendix Report 1.1), provided the data to do a time density analysis of the rate at which the spawning populations recruited to each of the surveyed stream reaches. This data was used in combination with assumptions about average migration time through the terminal area was used to derive estimates of average escapement timing, and run timing through the terminal marine area.

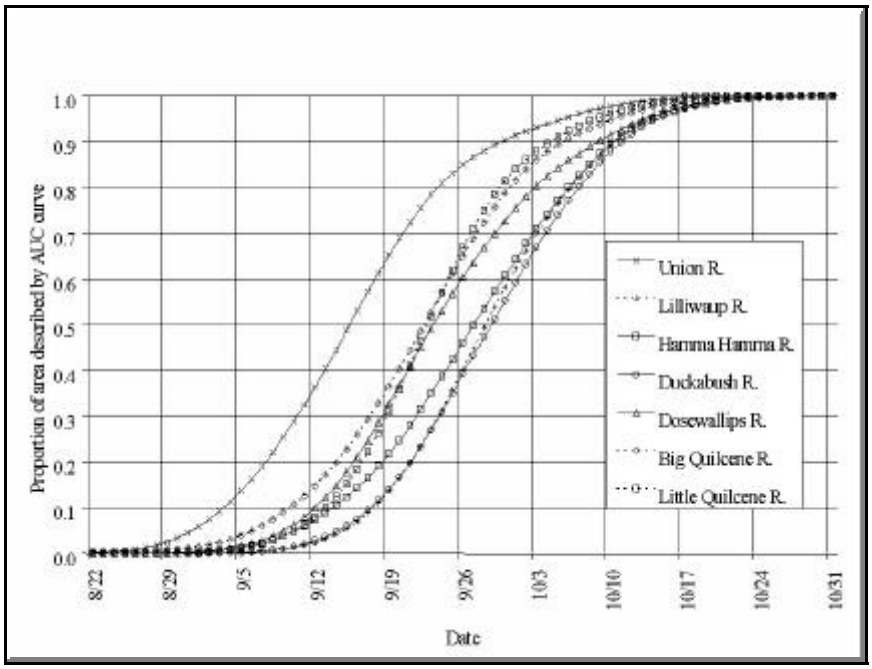
The area defined by each AUC curve can be described as a time density function. The proportion of the season total fish*days accumulated within each of the surveyed stream reaches at any given time point in the spawning run can be used as an indirect measure of the proportion of escapement completed for the season. This value is derived by :

Proportion of total fish*days accumulated for the season at day i = $p_i = \sum f_i / FD_T$

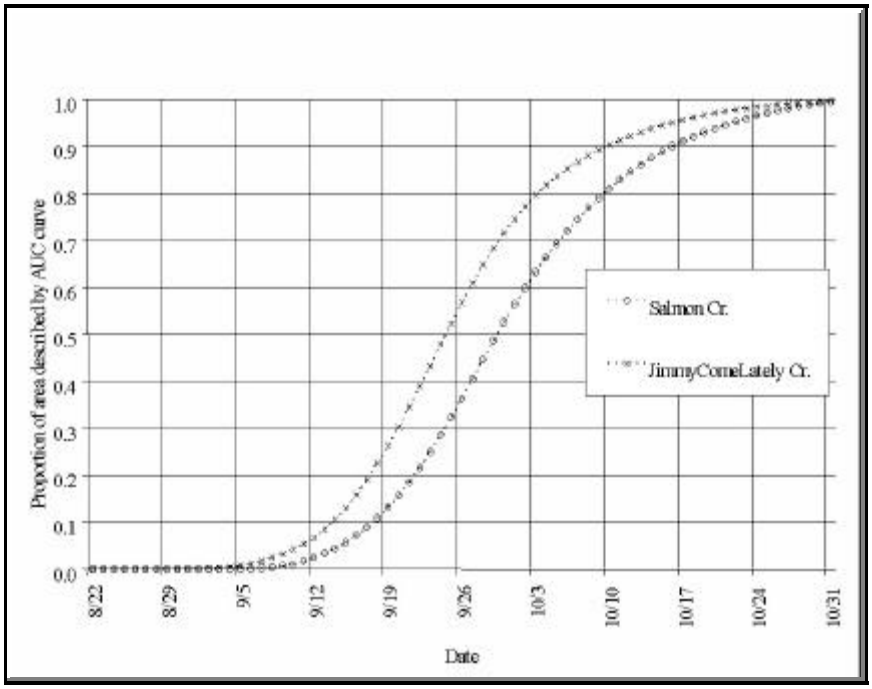
Where:

f_i = Live fish observed or estimated to have been present in the survey reach on the i^{th} day
FD_T = Season total fish*days

For each of the major summer chum spawning populations (still extant) the value p_i was calculated for each calendar day i through the spawning run, for each year that the spawning activity was adequately documented by surveys. These values were averaged for each calendar day i to provide an estimate of the average proportion of total fish*days accumulated at each day i in the in the index reaches (Appendix Figure 1.2.1 – Hood Canal streams, and Appendix Figure 1.2.2 – Strait of Juan de Fuca streams). Appendix Table 1.2.1 summarizes the average WDFW estimates of dates of 10, 50, and 90 % fish*day accumulation (i.e., estimated escapement) in the spawning streams.



Appendix Figure 1.2.1. Average proportion of summer chum fish * days accumulated through spawning period in Hood Canal region streams.



Appendix Figure 1.2.2. Average proportion of summer chum fish * days accumulated through spawning period in Strait of Juan de Fuca region streams.

Appendix Table 1.2.1. Average dates of 10, 50, and 90 % completion of escapement for selected Hood Canal and Strait of Juan de Fuca summer chum populations (WDFW).

Management Unit	Stock	N	Avg. 10 % comp.	Std. dev.	Range (min. and max.)	Avg. 50 % comp.	Std. dev.	Range (min. and max.)	Avg. 90 % comp.	Std. dev.	Range (min. and max.)
Sequim Bay	JimmyCL	15	9/14	+/- 4 d	9/6-9/23	9/24	+/- 4 d	9/17-10/2	10/10	+/- 8 d	9/28-10/25
Discovery Bay	Snow/Salmon	20	9/18	+/- 5 d	9/10-10/2	9/29	+/- 6 d	9/18-10/13	10/16	+/- 8 d	9/29-10/26
Area 12B	Dosewallips	13	9/12	+/- 5 d	9/7-9/25	9/23	+/- 4 d	9/18-10/3	10/9	+/- 6 d	9/28-10/18
	Duckabush	16	9/17	+/- 4 d	9/11-9/27	9/29	+/- 4 d	9/21-10/5	10/11	+/- 9 d	9/15-10/16
	Hamma Hamma	21	9/14	+/- 6 d	9/6-9/27	9/27	+/- 5 d	9/18-10/6	10/10	+/- 4 d	10/1-10/18
Area 12C	Lilliwaup	13	9/17	+/- 4 d	9/10-9/26	9/28	+/- 4 d	9/21-10/6	10/10	+/- 4 d	9/30-10/16
Area 12A	Big Quilcene	17	9/10	+/- 6 d	8/30-9/22	9/22	+/- 5 d	9/14-10/1	10/5	+/- 6 d	9/25-10/18
	Little Quilcene	12	9/13	+/- 4 d	9/7-9/19	9/23	+/- 4 d	9/18-9/30	10/4	+/- 6 d	9/25-10/14
Area 12D	Union	16	9/3	+/- 5 d	8/28-9/14	9/15	+/- 4 d	9/8-9/25	9/30	+/- 5 d	9/22-10/7

An example of how this information was used for management purposes is illustrated by planning of the 1998 terminal area fishery management periods for summer chum in 1998. WDFW used the Hood Canal Management Plan summer chinook management period start dates in each Hood Canal terminal marine management area (Areas 12-12D) as a conservative starting point for summer chum management concerns, and for the end period the calendar date that the average "p_i = 90 %" values for the streams entering each management unit occurred (Flint 1998). The one exception was for Area 12, where the completion date for the proposed summer chum management period was derived by subtracting 7 days from the 90 % p_i value for Area 12B streams. Appendix Table 1.2.2 summarizes these dates, which are based on the spawning timing information illustrated in Appendix Figures 1.2.1 and 1.2.2.

Appendix Table 1.2.2. WDFW proposed 1998 marine and in-river management unit fishery management periods.

Marine/In-river Management Unit	Date	Comments
12	7/12-10/9	Beginning date matches summer/fall chinook management period, and ending date backs out one week from 12B.
12A	7/12-10/10	Beginning date matches summer/fall chinook management period, and ending date is average 90% p_i value for Big Quilcene River.
Big Quilcene R.	8/25-10/19	Encompasses earliest and latest dates summer chum have been projected to have been present in Big Quilcene River.
12B	7/12-10/16	Beginning date matches summer/fall chinook management period, and ending date is average of average 90% p_i value for Duckabush, Dosewallips, and Hamma Hamma rivers.
12C	7/19-10/12	Beginning data matches summer/fall chinook management period, and ending date is average 90% p_i value for Lilliwaup River.
12D	7/19-10/7	Beginning date matches summer/fall chinook management period, and ending date is average 90% p_i value for Union River.

There are some potential analytical weaknesses in this approach. The first is that the majority of f_i values used to calculate p_i are approximated. Furthermore, the p_i values will not correspond directly to the proportion of total egg deposition that has occurred at time *i* for the season in the survey reach. For the purposes of this exercise we are assuming there is a correspondence, but it has not been experimentally measured. No data is available for the transit times of Hood Canal summer chums through the terminal marine areas to into the surveyed reaches of the spawning streams, so these values are currently only based on professional judgment.

! PNPTC analysis (Nick Lampsakis, PNPTC)

The estimates of run timing of summer chum salmon at various locations were developed using the probability distribution of the migratory time density. This approach is based on methods developed by numerous investigators (Walters and Buckingham, 1975; Mundy, 1979, 1982; Fried and Hilborn, 1988; Starr and Hilborn, 1988; Springborn et al, 1998; etc.) For further details on the rationale of the application of migratory time density, see above citations.

Simply put, the empirical function $f(t_i) = n_i / n$ is the "time density" of T, where T is the migratory timing. The expected value of T is then:

$$T = \sum_{i=1} t_i * f(t_i),$$

where:

In the case of spawner-count data, the actual daily live counts were converted to fish per mile, which, when divided by the season's estimated gross escapement (fish entering the river), provided n_i above. Before proceeding further, data from individual years were examined for continuity of sampling, distribution across the overall known time spectrum of entry, and total number of samples with fish/mile > 0. In no cases were values "filled in" or extrapolated, or interpolated through any means.

For the selected years in the record, the expected value of T was then estimated. This value varied between years, and since this variation is normally limited in salmonid populations (see above citations), any unusual deviations from the empirical mean of T were examined for data discrepancies. The results can be shown for the Big Quilcene River spawner counts, which were found to be:

T = 09/22

1974 = T+7
1975 = T+3
1978 = T-5
1979 = T-3
1980 = T+4
1981 = T-1
1982 = T-3
1985 = T+3
1988 = T+2
1991 = T+1
1992 = T-3
1993 = T+3
1994 = T+5
1995 = T-4
1996 = T-7
1997 = T-2

Unfortunately spawning ground counts are hardly continuous (estimates sometimes are nearly a month apart) and therefore these estimates may indicate a level of variability which is actually much lower. Regardless, however the above example indicates a maximum observed variability of 7 days, and no more than +/- 4 days within one standard deviation. It is worth noting, that while T may be estimated quite easily for any given year, using as few as 2-3 observations (if properly placed across the entry spectrum), it is not possible to describe the full entry pattern in a given year, without the use of "filled-in" values which would ultimately depend on subjective judgment. Therefore, in order to generate a complete timing profile, it is necessary to aggregate information from a number of years' observations, and this of course requires standardization of the data (done above) as well as elimination of the effects of inter-annual variability.

The expected entry pattern was estimated by using an average of the above 16 years. The previously estimated inter-annual variability can then be used to predict future variation. The resulting pattern describes the expected distribution through time, of the spawner count observations. Results are summarized by stock in Appendix Table 1.2.3. The timings shown in Appendix Table 1.2.3 are based on

observations of spawners in the surveyed stream reaches; they do not describe the timing of spawner entry to the observation locales. If surveys are spaced pretty far apart, it is quite possible that many of the individuals observed entered the spawning grounds as far back as two weeks previous, or more. However, for this initial analysis, we would use the assumption of a constant (across the run entry), average stream life of 10 days and therefore, assuming that some of the observed spawners are recent arrivals, and some are near the end of their stream life, we would back-date the spawner count profile by 5 days, in order to arrive at an estimated entry profile.

Appendix Table 1.2.3 – Average dates of 10, 50, and 90 % completion of fish escapement for selected Hood Canal and Strait of Juan de Fuca summer chum populations (PNPTC)

Management Unit	Stock	N	Avg. 10% comp.	Avg. 50% comp.	Std. dev.	Range (min. and max.)	Avg. 90% comp.
Sequim Bay	Jimmycomelately	14	9/17	9/26	+/- 4 d	9/19-10/2	10/9
Discovery Bay	Snow/Salmon	20	9/19	9/29	+/- 6 d	9/17-10/11	10/13
Area 12B	Dosewallips	16	9/13	9/25	+/- 4 d	9/16-10/4	10/9
	Duckabush	24	9/19	9/28	+/- 4 d	9/20-10/6	10/11
	Hamma Hamma	23	9/17	9/27	+/- 4 d	9/18-10/4	10/8
Area 12C	Lilliwaup	18	9/15	9/28	+/- 4 d	9/19-10/5	10/10
Area 12A	Big & Little Quil.	16	9/12	9/22	+/- 4 d	9/15-9/29	10/1
Area 12D	Union	18	9/6	9/16	+/- 3 d	9/11-9/22	9/29

One obvious source of potential error is the assumption concerning a constant stream life, across the entire spectrum of the run. We have no direct method to correct for this, however historical tagging studies of adult salmon seem to indicate that the stream life of early arrivals may be much greater than that of spawners arriving after the middle of the run.

Reliable estimates for marine areas have been developed for north Hood Canal (Area 12) using 10 years of useable data (T = 9/14 (average 50% complete) with maximum variability from 9/8 to 9/18 and no more than 3 days within 1 standard dev.); and for Area 12A (Quilcene/Dabob bays), using 8 years of useable data (T = 9/13 (average 50% complete) with maximum variability from 9/8 to 9/15 and no more than 2 days within one standard dev.). For these marine areas, gillnet catch/landing data were used (this gear is preferred because of its passive sampling nature) instead of spawners/mile. Instead of gross escapement, the estimated annual recruitment to the area was used.

An unique problem in marine area samples involves the separation of summer from fall chum salmon. The end of the summer chum migration appears to slightly overlap the beginning of the fall migration. Since the fall populations are larger, by orders of magnitude, a small error in the selection of the last data point for summer chum, can have an enormous effect on f(t) above; that is, where a very large number of fall chum, relative to the overall summer chum abundance, control the value of n_i. In the case of Area 12A, this problem is not as significant because the fall chum are of a later variety. But in Area 12, despite our effort to select a point of consistently low chum abundance, the number of fish at that point may still include a significant number of fall chum. The only way to resolve this would be through GSI sampling of the suspected overlap period, in order to assign relative proportions of summer and fall chum to each time segment. The period of suspected overlap is from 9/20 through 10/10.

In marine areas of Hood Canal where no robust samples exist (Area 12B and 12C) we used the relationship developed between the Quilcene River entry, and the marine Area 12A entry profile, to develop marine area profiles, using the Dosewallips, Duckabush, and Hamma Hamma river entries for Area 12B, and the Union River (with minor additional backing out) for Area 12C.

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Appendix Report 1.3
Methodology For Summer Chum Salmon Run Reconstruction

Run re-construction is a post season accounting procedure used by the Washington Department of Fish and Wildlife and Tribes to assign catches to contributing populations; resulting in total annual run size estimates for individual wild and hatchery populations. Harvests in each management unit are apportioned to each stock by timing and presumed migration route on a proportional basis, and are sequentially added (from the streams and extreme terminal areas outward to terminal and pre-terminal areas) to population escapement estimates to arrive at total run size estimates. For Hood Canal summer chum salmon the previous co-manager's standard run re-construction model mis-allocates substantial numbers of early arriving fall chum salmon to summer chum salmon run size estimates (see discussion in Part One). For the current recovery planning process, a separate run re-construction was developed using earlier cutoff dates for allocating harvests during the summer chum period to reduce the influence of fall chum on summer chum run size estimates. However, some mis-allocation remains. The following is a brief summary of the methods used in this run re-construction.

Escapements

The escapement estimates used for this run re-construction were from the revised estimates of summer chum salmon escapements prepared during the recovery planning process (see Appendix Report 1.1).

Harvest Data

Commercial harvest data were obtained from the Northwest Indian Fisheries Commission (NWIFC) databases (TFT and MHCLS), for all fisheries of concern in U.S. waters. Canadian harvest estimates for Area 20 were obtained from L. HopWo (CDFO - Naniamo). Only one major correction was applied to the data retrieved from these sources; catches by the Skokomish Tribe in 1976 were erroneously coded as "central Hood Canal", and were corrected here to "southern Hood Canal" (Area 12C). The correction was made on the basis of PNPTC data tapes, previously submitted to WDFW for database correction. The run reconstruction has been updated to include all years from 1974 through 1998 (25 years). However, it is somewhat incomplete at the time of preparation because the 1998 catch data from PST test fisheries in Area 20 had not yet been received. There were no commercial catches in Area 20, in 1998, during the period of interest. Also, the 1998 Washington data was at the time still considered preliminary, and may be modified.

Recreational harvest data were provided by WDFW for Puget Sound fisheries from 1974 through 1996 (1997 and 1998) data are unavailable at present) in the Strait of Juan de Fuca, San Juan Islands,

Admiralty Inlet, and Hood Canal. Additionally, freshwater recreational harvest data were provided by WDFW for the Big Quilcene and Skokomish rivers for the 1976-1994 period. It was not possible to access data for the remaining years in these systems, however, given the low levels of reported caches in other years, it is not anticipated that there will be a significant effect on run re-construction. No data were used from fisheries west of the Bonilla-Tatoosh line.

Re-construction was accomplished by use of a proportional contribution assumption in all Hood Canal areas, whereby the harvest in each area was attributed proportionally to the stocks with streams of origin located "upstream" from the harvest location. In all cases, random distribution of the available populations was assumed. No Hood Canal summer chum were presumed to have been harvested in Area 10. Summer chum returning to both Hood Canal and the Strait of Juan de Fuca were presumed to be subject to harvest in Area 9. U.S. Convention areas' harvest was added to each management unit, with no assumption of any separate migratory pathway. Finally, Canadian harvests were added to the entire region, and its management units.

The results of the reconstruction are shown in the attached tables; summarized by individual management unit and include total run size estimates for the Hood Canal and the Strait of Juan de Fuca regions.

Run reconstruction details:

Data - Inconsistent and insufficient data were found for some years preceding 1974. Therefore, because of data limitations, run reconstruction was limited to the 1974-to-the-present period. The data used in the summer chum reconstruction are as follows:

Spawning escapements - as re-assessed in 1998, for each stock where counts existed. For some stocks, as well as reaches within units, where no direct estimates were possible, estimates were "filled in", using a variety of methods (interpolation, extrapolation, regression statistics, etc.) More details can be found in the description of escapement estimation methods (Appendix Report 1.1). In two cases (Dungeness and Skokomish rivers) no estimates are available for any year. Therefore, the reconstruction is incomplete, and biased to a certain degree.

Catch data - initially include all reported, or estimated, commercial and recreational catches of chum salmon in the following areas and time periods:

Canadian Area 20: July 1 through September 15
Washington Areas 4B, 5, 6, 6A, 6B, 6C, 7: July 1 through September 15
Washington Area 9: July 1 through September 8
Washington Area 10: July 1 through September 1
Washington Areas 12, 9A: July 1 through September 27
Washington Areas 12B, 12C, 12D: July 1 through September 30
Washington Area 12A: July 1 through October 5
Big Quilcene R. and Skokomish R.: July 1 through October 10

Commercial catches were available on a daily basis. Recreational catches are estimated on a monthly basis and we used a straight line proportion, for reconstruction periods of less than a month. The time periods were generally based on reviews of the data series, and establishment of cutoff dates to separate summer from fall chum, in an effort to equalize the number of summer chum after the cutoff date, with the number of fall chum before the cutoff date. This was done to avoid an assessment bias in either direction. No precise information concerning the relative proportions of each segment, on each date and area, is currently available. However, we believe that any remaining bias may be quite small.

Commercial and recreational catches in each area were further apportioned between the summer chum of this region, and other commingled populations, using the following methods:

Canadian Area 20 and Washington Areas 4B, 5, 6, 6A, 6B, 6C: 7-day segments were assigned stock composition proportions, based on Area 20 GSI samples of recent years.

Washington Areas 9, 10: All chum before 9/8 (Area 9) and 9/1 (Area 10) were assumed to be HC-SJF summer chum, and all chum following this date, were assumed to be from other Puget Sound regions (cutoff date method). For instance in Area 10, the higher abundance of South Sound early fall chum was assumed to far outweigh HC-SJF summer chum abundance after 9/1, and the reverse was assumed for earlier periods.

Washington Areas 9A, 12. 12A, 12B, 12C, 12D, 82F, 82G: all chum during the specified period were assumed to be of HC-SJF summer chum.

Methods - The annual reconstruction of runs was accomplished using a series of incremental additive steps, starting from spawning escapements and ending with the addition of near-ocean catches, with the intent to reconstruct the total annual recruitment of each management unit (MU), to all fisheries and escapement.

Assumptions - Major assumptions used in the reconstruction are included the following:

> Catches in each reporting area and fishery were assumed to be a random mix of all stocks and management units passing through the area. For individual stocks, this assumption was only used within the terminal areas of Hood Canal.
>
> All passing populations were assumed to be equally available for harvest in each area, regardless of their entry timing. For instance, SE Hood Canal (Union River) chum were assumed to be equally available at all times, along with other management units, despite their somewhat earlier timing. This assumption probably biased upwards the estimates of the population size and exploitation rates on it. At the same time, it probably biased low the population sized and exploitation rates on commingled populations, in all preceding fisheries. This effect obviously becomes more pronounced in fisheries where lesser numbers of other populations are present, and/or where exploitation (as a proportion of the total) is higher.

A straight-line migratory pathway was assumed in all cases. That is, stocks whose river of origin lies further "out", were assumed to have no contribution to catches further "inshore". If this assumption were incorrect, to a significant degree, it would result in mis-apportionment of catches, to individual MUs and a downward bias in our estimates of abundance of units further "out", with the reverse being true for units returning to streams further "inshore".

The final estimates, are not true "recruitment" estimates because we have not attempted to estimate, or add certain components, including: natural mortality in the year of maturity, non landed mortalities (drop-offs, predation from gear, etc.), catches in Canadian fisheries outside of Area 20, or US fisheries in ocean areas, or Area 7A. Some of these catches may be quite small and nearly insignificant, however if HC-SJF summer chum salmon migrate to US waters through the Canadian "inside passage", mortalities in Canadian Areas 11-13 and 29 could be significant. All of the above were excluded from the present reconstruction because of the complete lack of appropriate data (see following run reconstruction tables for the years 1974-98).

Reconstruction Steps :

1. SE Hood Canal escapements expanded to Area 12D whose catches were apportioned by population strength. The total provided estimated return to Area 12D

2. Area 82G escapements (zero) were added to catches in 82G.

3. Escapements to Area 12C tributaries, including fish taken for supplementation, and any pre-spawning mortalities, and the totals from 1. and 2. above, were used to apportion Area 12C catches to each component, by population strength, and expand these components to obtain the run size entering Area 12C.

4. Escapements to Area 12A streams, including pre-spawning mortalities and fish taken for supplementation, were added to any in-river catches, to obtain in-river run sizes. Catches in Area 12A were apportioned to each stock by population strength and expanded them to obtain run sizes entering Area 12A.

5. Escapements to Area 12B rivers, and the totals from 3. and 4. above, were used to apportion Area 12B catches to each component, by population strength, and expand these components to obtain the run size entering Area 12B.

6. Escapements to Area 12 streams, and the total from 5. above, were used to apportion Area 12 catches (including Hood Canal marine recreational) to each component, by population strength, and expand these components to obtain the run size entering Area 12.

7. Catches in Area 9A were apportioned by population strength and added to the totals from 6. above, to obtain the total terminal area return of each stock and management unit originating in

Hood Canal. Each Hood Canal management unit was further expanded by apportioning to it catches from Area 10.

8. The terminal run sizes of the Sequim and Discovery management units were estimated by adding catches in Sequim and Discovery bays to their escapements and fish taken for supplementation.

9. Commercial and recreational catches in Area 9, Washington Areas 4B, 5, 6, 6A, 6B, 6C, 7, and Canadian Area 20 were apportioned to the management units in 7. and 8. above, by management unit strength, to expand these units, and obtain estimates of MU strength entering Area 9 (Admiralty), Washington waters, and Canadian waters, respectively. The sum total of these, provided an annual estimate of region's recruits to all fisheries and escapements.

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1974**	**Harvest**		356	0	0	0	0	12	12	0	0	0		0	190	188	1,399
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		356		356			356	357	357			357	357	361	366	401
12D	Tahuya	880			880	880			881	882	882			950	950	962	975	1,067
	Union	68			68	68			68	68	68							
12A	L. Quilcene	44						44	44	44	44			841	841	852	863	944
	B. Quilcene	795					795	795	796	797	797							
12-12B-12C	Big Beef	75							75	75	75			10,515	10,515	10,654	10,791	11,810
	Anderson	0							0	0	0							
	Dosewallips	***3,593***							3,596	3,600	3,600							
	Duckabush	3,581							3,585	3,588	3,588							
	HammaHamma	***2,448***							2,451	2,453	2,453							
	Lilliwaup	616				616			617	617	617							
	Dewatto	181				181			181	181	181							
Discovery	Snow	818										818		1,330		1,348	1,365	1,494
	Salmon	512										512						
Sequim	Jimmycomelatel	***438***											438	438		443	449	492
Totals		14,049	0	356	948	2,101	795	839	12,650	12,662	12,662	1,330	438	14,430	12,662	14,620	14,808	16,207
	Hood Canal	12,281	0											12,662	12,662	12,829	12,994	14,222
	E. Strait Portion	1,768	0											1,768		1,791	1,814	1,985

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1975**	**Harvest**		1,118	54	4,010	0	372	3,664	78	0	205	0		0	54	546	1,064
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		1,118		2,249			2,595	2,601	2,601			2,601	2,601	2,605	2,654	2,749
12D	Tahuya	1,389			1,440	2,897			3,342	3,352	3,352			3,555	3,555	3,561	3,628	3,757
	Union	***84***			87	175			202	203	203							
12A	L. Quilcene	868						1,010	1,166	1,169	1,169			3,061	3,061	3,066	3,124	3,235
	B. Quilcene	1,405					1,405	1,635	1,887	1,892	1,892							
12-12B-12C	Big Beef	1,152							1,329	1,333	1,333			18,326	18,326	18,360	18,703	19,371
	Anderson	195							225	226	226							
	Dosewallips	***2,250***							2,596	2,604	2,604							
	Duckabush	2,245							2,591	2,598	2,598							
	HammaHamma	***7,341***							8,471	8,495	8,495							
	Lilliwaup	706				1,420			1,639	1,643	1,643							
	Dewatto	613				1,233			1,423	1,427	1,427							
Discovery	Snow	327										389		1,287		1,289	1,313	1,360
	Salmon	755										898						
Sequim	Jimmycomelatel	***348***											348	348		348	355	368
Totals		19,678	0	1,118	1,527	7,974	1,405	2,645	27,466	27,541	27,541	1,287	348	29,176	27,541	29,230	29,776	30,840
	Hood Canal	18,248	0											27,541	27,541	27,592	28,108	29,112
	E. Strait Portion	1,430	0											1,635		1,638	1,668	1,728

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1976**	**Harvest**		991	618	26,150	0	5,704	4,046	86	0	0	0		968	1,486	929	5,705
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		991		4,560			4,861	4,865	4,865			4,865	4,937	5,045	5,113	5,529
12D	Tahuya	3,200			3,799	17,480			18,636	18,661	18,661			19,244	19,530	19,958	20,225	21,869
	Union	100			119	546			582	583	583							
12A	L. Quilcene	1,088						2,845	3,033	3,037	3,037			9,861	10,007	10,227	10,364	11,206
	B. Quilcene	2,445					2,445	6,392	6,815	6,824	6,824							
12-12B-12C	Big Beef	1,281							1,366	1,368	1,368			31,339	31,803	32,500	32,936	35,613
	Anderson	234							249	250	250							
	Dosewallips	3,271							3,487	3,492	3,492							
	Duckabush	6,095							6,498	6,507	6,507							
	HammaHamma	***7,648***							8,154	8,165	8,165							
	Lilliwaup	1,612				7,417			7,907	7,918	7,918							
	Dewatto	741				3,409			3,635	3,640	3,640							
Discovery	Snow	608										608		1,129		1,154	1,169	1,264
	Salmon	521										521						
Sequim	Jimmycomelatel	***365***											365	365		373	378	409
Totals		29,209	0	991	3,918	33,412	2,445	9,237	65,225	65,309	65,309	1,129	365	66,803	66,277	69,256	70,186	75,891
	Hood Canal	27,715	0											65,309	66,277	67,730	68,638	74,218
	E. Strait Portion	1,494	0											1,494		1,527	1,547	1,673

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1977**	**Harvest**		320	7	3,015	0	24	590	488	0	0	0		1	73	711	913
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		320		864			900	921	921			921	921	925	964	1,014
12D	Tahuya	726			732	1,978			2,061	2,129	2,129			2,349	2,349	2,359	2,459	2,587
	Union	75			76	204			213	220	220							
12A	L. Quilcene	773						785	817	845	845			1,742	1,742	1,750	1,823	1,918
	B. Quilcene	821					821	833	868	897	897							
12-12B-12C	Big Beef	302							315	325	325			10,134	10,135	10,179	10,608	11,159
	Anderson	***26***							27	28	28							
	Dosewallips	3,215							3,350	3,461	3,461							
	Duckabush	2,453							2,556	2,641	2,641							
	HammaHamma	***1,675***							1,745	1,803	1,803							
	Lilliwaup	420				1,134			1,182	1,221	1,221							
	Dewatto	225				608			633	654	654							
Discovery	Snow	538										538		1,239		1,244	1,297	1,364
	Salmon	701										701						
Sequim	Jimmycomelatel	***405***											405	405		406	424	446
Totals		12,355	0	320	808	4,788	821	1,618	14,667	15,146	15,146	1,239	405	16,790	15,147	16,864	17,575	18,488
	Hood Canal	10,711	0											15,146	15,147	15,213	15,855	16,679
	E. Strait Portion	1,644	0											1,644		1,651	1,720	1,810

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1978**	**Harvest**		130	0	2,036	0	1	386	1,817	6	0	0		0	167	552	701
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		130		243			248	261	261			261	261	262	268	275
12D	Tahuya	266			266	498			507	548	548			680	680	684	698	716
	Union	64			64	120			122	132	132							
12A	L. Quilcene	1,816						1,816	1,848	1,999	2,000			5,279	5,279	5,311	5,418	5,554
	B. Quilcene	2,978					2,978	2,979	3,031	3,279	3,279							
12-12B-12C	Big Beef	680							692	748	749			17,858	17,858	17,968	18,331	18,791
	Anderson	16							16	18	18							
	Dosewallips	***1,901***							1,935	2,093	2,093							
	Duckabush	1,898							1,931	2,089	2,090							
	HammaHamma	***8,215***							8,360	9,043	9,045							
	Lilliwaup	1,331				2,492			2,536	2,742	2,743							
	Dewatto	544				1,018			1,036	1,121	1,121							
Discovery	Snow	629										629		2,293		2,307	2,354	2,413
	Salmon	1,664										1,664						
Sequim	Jimmycomelatel	***787***											787	787		791	807	828
Totals		22,789	0	130	330	4,371	2,978	4,795	22,263	24,073	24,078	2,293	787	27,158	24,078	27,324	27,876	28,576
	Hood Canal	19,710	0											24,078	24,078	24,226	24,715	25,336
	E. Strait Portion	3,080	0											3,080		3,098	3,161	3,240

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1979**	**Harvest**		31	0	950	0	137	218	146	0	0	0		2	134	889	591
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		31		95			98	100	100			100	100	101	111	118
12D	Tahuya	117			117	360			370	377	377			690	690	701	771	817
	Union	***97***			97	299			307	313	313							
12A	L. Quilcene	110						143	147	150	150			620	620	630	692	734
	B. Quilcene	345					345	449	462	470	470							
12-12B-12C	Big Beef	191							196	200	200			6,627	6,628	6,729	7,399	7,844
	Anderson	6							6	6	6							
	Dosewallips	***1,190***							1,224	1,246	1,246							
	Duckabush	1,190							1,224	1,247	1,247							
	HammaHamma	***3,096***							3,185	3,244	3,244							
	Lilliwaup	163				502			516	526	526							
	Dewatto	49				151			155	158	158							
Discovery	Snow	133										133		591		600	660	699
	Salmon	458										458						
Sequim	Jimmycomelatel	***170***											170	170		173	190	201
Totals		7,315	0	31	214	1,407	345	592	7,891	8,037	8,037	591	170	8,798	8,039	8,934	9,823	10,413
	Hood Canal	6,554	0											8,037	8,039	8,161	8,973	9,513
	E. Strait Portion	761	0											761		773	849	900

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1980**	**Harvest**		17	0	773	18	156	2,912	4,280	1	0	0		6	97	474	980
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		17		34			55	78	78			78	78	79	81	85
12D	Tahuya	179			179	359			580	904	904			1,955	1,956	1,967	2,021	2,134
	Union	208			208	417			674	1,050	1,051							
12A	L. Quilcene	154						198	319	498	498			1,770	1,770	1,780	1,830	1,932
	B. Quilcene	375					393	505	815	1,271	1,271							
12-12B-12C	Big Beef	123							199	310	310			8,124	8,128	8,174	8,400	8,868
	Anderson	2							3	5	5							
	Dosewallips	1,216							1,963	3,061	3,061							
	Duckabush	827							1,335	2,082	2,082							
	HammaHamma	329							531	828	828							
	Lilliwaup	247				496			800	1,247	1,248							
	Dewatto	117				235			379	591	591							
Discovery	Snow	709										709		3,783		3,804	3,910	4,127
	Salmon	3,074										3,074						
Sequim	Jimmycomelatel	***1,326***											1,326	1,326		1,334	1,371	1,447
Totals		8,886	0	17	387	1,541	393	703	7,652	11,925	11,926	3,783	1,326	17,036	11,932	17,138	17,613	18,592
	Hood Canal	3,777	0											11,926	11,932	12,000	12,332	13,018
	E. Strait Portion	5,109	0											5,109		5,138	5,281	5,574

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1981**	**Harvest**		116	0	158	2	137	466	1,294	3	0	0		6	63	597	915
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		116		145			169	219	219			219	220	222	246	283
12D	Tahuya	140			140	175			204	286	286			369	370	374	415	477
	Union	41			41	51			60	84	84							
12A	L. Quilcene	84						135	158	221	221			589	590	597	662	761
	B. Quilcene	138					140	226	263	368	368							
12-12B-12C	Big Beef	90							105	147	147			3,354	3,359	3,398	3,767	4,334
	Anderson	1							1	2	2							
	Dosewallips	63							74	103	103							
	Duckabush	557							650	909	909							
	HammaHamma	926							1,081	1,511	1,512							
	Lilliwaup	293				366			428	598	598							
	Dewatto	41				51			60	84	84							
Discovery	Snow	242										242		681		689	764	879
	Salmon	439										439						
Sequim	Jimmycomelatel	***203***											203	203		205	227	261
Totals		3,258	0	116	181	789	140	361	3,253	4,529	4,532	681	203	5,416	4,538	5,485	6,081	6,997
	Hood Canal	2,374	0											4,532	4,538	4,591	5,090	5,857
	E. Strait Portion	884	0											884		894	991	1,140

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1982**	**Harvest**		90	0	245	0	304	726	2,485	0	0	0		0	132	296	2,219
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		90		141			172	253	253			253	253	257	265	326
12D	Tahuya	86			86	135			164	267	267			743	743	753	777	956
	Union	***153***			153	240			293	476	476							
12A	L. Quilcene	125						260	318	516	516			1,161	1,161	1,177	1,215	1,495
	B. Quilcene	156					156	325	397	644	644							
12-12B-12C	Big Beef	0							0	0	0			4,291	4,291	4,352	4,490	5,525
	Anderson	***0***							0	0	0							
	Dosewallips	507							620	1,006	1,006							
	Duckabush	690							844	1,369	1,369							
	HammaHamma	801							979	1,589	1,589							
	Lilliwaup	84				131			161	261	261							
	Dewatto	21				33			40	65	65							
Discovery	Snow	766										766		2,152		2,183	2,252	2,771
	Salmon	1,386										1,386						
Sequim	Jimmycomelatel	599											599	599		608	627	771
Totals		5,374	0	90	239	679	156	585	3,988	6,447	6,447	2,152	599	9,198	6,447	9,330	9,626	11,845
	Hood Canal	2,623	0											6,447	6,447	6,540	6,747	8,302
	E. Strait Portion	2,751	0											2,751		2,790	2,879	3,543

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1983**	**Harvest**		23	0	209	276	1,131	105	664	9	0	0		2	131	146	28
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		23		38			40	45	45			45	45	47	48	49
12D	Tahuya	86			86	144			150	188	188			560	561	577	596	599
	Union	170			170	284			296	371	372							
12A	L. Quilcene	176						562	585	734	736			2,157	2,158	2,222	2,293	2,307
	B. Quilcene	64					340	1,085	1,131	1,419	1,421							
12-12B-12C	Big Beef	0							0	0	0			510	510	526	542	546
	Anderson	0							0	0	0							
	Dosewallips	64							67	84	84							
	Duckabush	80							83	105	105							
	HammaHamma	190							198	248	249							
	Lilliwaup	18				30			31	39	39							
	Dewatto	15				25			26	33	33							
Discovery	Snow	154										154		885		911	941	946
	Salmon	731										731						
Sequim	Jimmycomelatel	254											254	254		262	270	272
Totals		2,002	0	23	256	521	340	1,647	2,607	3,266	3,272	885	254	4,411	3,274	4,544	4,690	4,718
	Hood Canal	863	0											3,272	3,274	3,372	3,480	3,500
	E. Strait Portion	1,139	0											1,139		1,173	1,210	1,218

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1984**	**Harvest**		70	0	80	75	902	112	458	2	0	0		5	3	65	314
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		70		79			82	91	91			91	91	91	92	98
12D	Tahuya	142			142	160			167	196	196			463	464	464	471	502
	Union	194			194	218			228	267	268							
12A	L. Quilcene	83						426	445	522	522			1,372	1,374	1,375	1,394	1,486
	B. Quilcene	60					135	694	724	849	849							
12-12B-12C	Big Beef	22							23	27	27			1,181	1,183	1,184	1,200	1,279
	Anderson	1							1	1	1							
	Dosewallips	212							221	260	260							
	Duckabush	299							312	366	366							
	HammaHamma	***170***							178	208	208							
	Lilliwaup	187				210			220	258	258							
	Dewatto	44				50			52	61	61							
Discovery	Snow	384										384		1,212		1,213	1,230	1,311
	Salmon	828										828						
Sequim	Jimmycomelatel	367											367	367		367	372	397
Totals		2,993	0	70	336	717	135	1,120	2,654	3,105	3,107	1,212	367	4,686	3,112	4,694	4,759	5,073
	Hood Canal	1,414	0											3,107	3,112	3,114	3,157	3,365
	E. Strait Portion	1,579	0											1,579		1,580	1,602	1,708

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1985**	**Harvest**		70	0	56	40	274	288	648	10	0	0		2	40	445	1,620
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		70		76			90	111	111			111	111	113	131	197
12D	Tahuya	122			122	133			157	213	214			799	800	812	943	1,420
	Union	334			334	363			431	583	585							
12A	L. Quilcene	1						4	5	7	7			577	578	586	681	1,026
	B. Quilcene	44					84	355	421	569	570							
12-12B-12C	Big Beef	0							0	0	0			995	996	1,011	1,174	1,768
	Anderson	0							0	0	0							
	Dosewallips	236							280	379	380							
	Duckabush	30							36	48	48							
	HammaHamma	***231***							274	371	372							
	Lilliwaup	92				100			119	161	161							
	Dewatto	19				21			25	33	33							
Discovery	Snow	20										20		171		174	202	304
	Salmon	151										151						
Sequim	Jimmycomelatel	61											61	61		62	72	108
Totals		1,341	0	70	456	693	84	359	1,837	2,473	2,483	171	61	2,715	2,485	2,757	3,202	4,822
	Hood Canal	1,109	0											2,483	2,485	2,521	2,929	4,411
	E. Strait Portion	232	0											232		235	273	412

Note: Values in bold italics were estimated indirectly

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1986**	**Harvest**		35	0	55	22	561	1,348	2,432	4	0	0		0	21	146	796
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		35		36			51	68	68			68	68	68	69	76
12D	Tahuya	109			109	112			159	243	243			4,460	4,460	4,472	4,552	4,991
	Union	1,892			1,892	1,940			2,751	4,215	4,217							
12A	L. Quilcene	12						149	212	324	325			1,325	1,325	1,329	1,353	1,483
	B. Quilcene	15					37	461	653	1,000	1,001							
12-12B-12C	Big Beef	0							0	0	0			1,145	1,145	1,148	1,169	1,282
	Anderson	0							0	0	0							
	Dosewallips	57							81	124	124							
	Duckabush	177							251	384	385							
	HammaHamma	173							245	376	376							
	Lilliwaup	97				99			141	216	216							
	Dewatto	20				21			29	45	45							
Discovery	Snow	213										213		795		797	811	890
	Salmon	582										582						
Sequim	Jimmycomelatel	292											292	292		293	298	327
Totals		3,639	0	35	2,001	2,208	37	610	4,573	6,995	6,998	795	292	8,085	6,998	8,106	8,253	9,049
	Hood Canal	2,552	0											6,998	6,998	7,017	7,143	7,832
	E. Strait Portion	1,087	0											1,087		1,090	1,109	1,217

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1987**	**Harvest**		43	0	56	3	1,603	302	860	4	0	0		0	0	147	390
														Management				
			Broo	**********			Run Abundance by Location				**********				Seattle	Admira	US	Cana
Mgmt Unit	Prod. Unit	Escapeme	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Disco	Sequi	Term.	(Area	(Area	Conv.	Area
Skokomish	Skokomish	N/A		43		47			52	61	61			61	61	61	63	67
12D	Tahuya	91			91	99			111	145	145			939	939	939	964	1,029
	Union	497			497	539			605	793	794							
12A	L. Quilcene	71						1,459	1,638	2,148	2,149			2,482	2,482	2,482	2,547	2,719
	B. Quilcene	8					11	226	254	333	333							
12-12B-12	Big Beef	6							7	9	9			137	137	137	141	150
	Anderson	0							0	0	0							
	Dosewallips	9							10	13	13							
	Duckabush	12							13	18	18							
	HammaHam	26							29	38	38							
	Lilliwaup	32				35			39	51	51							
	Dewatto	5				5			6	8	8							
Discovery	Snow	465										465		1,527		1,527	1,567	1,673
	Salmon	1,062										1,062						
Sequim	Jimmycomelat	464											464	464		464	476	508
Totals		2,748	0	43	588	724	11	1,685	2,764	3,616	3,619	1,527	464	5,610	3,619	5,610	5,757	6,147
	Hood Canal	757	0											3,619	3,619	3,619	3,714	3,965
	E. Strait	1,991	0											1,991		1,991	2,043	2,181

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1988**	**Harvest**		43	0	30	17	1,897	93	30	12	0	0		5	0	305	738
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		43		44			45	45	45			45	45	45	47	51
12D	Tahuya	145			145	149			152	153	153			816	817	817	846	914
	Union	629			629	646			658	662	664							
12A	L. Quilcene	177						1,246	1,270	1,277	1,279			2,269	2,271	2,271	2,350	2,541
	B. Quilcene	120					137	965	983	989	990							
12-12B-12C	Big Beef	0							0	0	0			1,956	1,958	1,958	2,026	2,190
	Anderson	0							0	0	0							
	Dosewallips	661							673	677	679							
	Duckabush	497							506	509	511							
	HammaHamma	440							448	451	452							
	Lilliwaup	275				282			288	289	290							
	Dewatto	23				24			24	24	24							
Discovery	Snow	723										723		2,638		2,638	2,730	2,951
	Salmon	1,915										1,915						
Sequim	Jimmycomelatel	1,052											1,052	1,052		1,052	1,089	1,177
Totals		6,657	0	43	774	1,145	137	2,211	5,047	5,077	5,086	2,638	1,052	8,776	5,091	8,781	9,086	9,825
	Hood Canal	2,967	0											5,086	5,091	5,091	5,268	5,696
	E. Strait Portion	3,690	0											3,690		3,690	3,818	4,128

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1989**	**Harvest**		18	0	49	29	339	606	536	11	0	0		1	4	421	2,273
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		18		20			31	38	38			38	38	38	44	78
12D	Tahuya	9			9	10			16	21	21			1,063	1,063	1,065	1,239	2,179
	Union	450			450	492			781	1,036	1,042							
12A	L. Quilcene	1						12	19	25	25			781	782	783	911	1,602
	B. Quilcene	1					30	358	568	754	756							
12-12B-12C	Big Beef	0							0	0	0			299	299	299	348	613
	Anderson	0							0	0	0							
	Dosewallips	16							25	34	34							
	Duckabush	60							95	126	127							
	HammaHamma	16							25	34	34							
	Lilliwaup	43				47			75	99	100							
	Dewatto	2				2			3	5	5							
Discovery	Snow	21										21		215		215	251	441
	Salmon	194										194						
Sequim	Jimmycomelatel	173											173	173		173	202	355
Totals		986	0	18	459	571	30	370	1,640	2,171	2,181	215	173	2,569	2,182	2,574	2,994	5,267
	Hood Canal	598	0											2,181	2,182	2,185	2,542	4,472
	E. Strait Portion	388	0											388		389	452	795

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1990**	**Harvest**		58	0	43	29	307	36	48	67	0	0		0	0	45	696
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		58		65			68	70	75			75	75	75	78	116
12D	Tahuya	6			6	7			7	7	8			372	372	372	384	577
	Union	275			275	310			323	340	364							
12A	L. Quilcene	0						0	0	0	0			389	389	389	402	604
	B. Quilcene	6					35	342	356	375	389							
12-12B-12C	Big Beef	0							0	0	0			167	167	167	173	259
	Anderson	0							0	0	0							
	Dosewallips	8							8	9	9							
	Duckabush	42							44	46	49							
	HammaHamma	90							94	99	106							
	Lilliwaup	2				2			2	2	3							
	Dewatto	0				0			0	0	0							
Discovery	Snow	33										33		278		278	287	431
	Salmon	245										245						
Sequim	Jimmycomelatel	63											63	63		63	65	98
Totals		770	0	58	281	384	35	342	902	948	1,003	278	63	1,344	1,003	1,344	1,389	2,085
	Hood Canal	429	0											1,003	1,003	1,003	1,037	1,556
	E. Strait Portion	341	0											341		341	352	529

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1991**	**Harvest**		3	0	13	31	751	0	6	66	0	0		0	59	171	483
														Management Unit				
			Brood		**********		Run Abundance by Location					**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		3		3			3	3	3			3	3	3	4	5
12D	Tahuya	5			5	5			5	5	5			233	233	241	262	321
	Union	208			208	218			218	219	228							
12A	L. Quilcene	1						10	10	10	11			853	853	879	956	1,172
	B. Quilcene	49					80	822	822	825	843							
12-12B-12C	Big Beef	0							0	0	0			507	507	523	569	697
	Anderson	0							0	0	0							
	Dosewallips	250							250	251	262							
	Duckabush	102							102	102	107							
	HammaHamma	69							69	69	72							
	Lilliwaup	30				31			31	32	33							
	Dewatto	31				32			32	33	34							
Discovery	Snow	12										12		184		190	206	253
	Salmon	172										172						
Sequim	Jimmycomelatel	125											125	125		129	140	172
Totals		1,054	0	3	213	290	80	832	1,543	1,549	1,597	184	125	1,906	1,597	1,965	2,136	2,620
	Hood Canal	745	0											1,597	1,597	1,647	1,790	2,195
	E. Strait Portion	309	0											309		319	346	425

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1992**	**Harvest**		7	0	0	9	199	0	0	8	0	0		1	44	84	980
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		7		7			7	7	7			7	7	7	7	9
12D	Tahuya	0			0	0			0	0	0			140	140	142	145	183
	Union	140			140	140			140	140	140							
12A	L. Quilcene	9						11	11	11	11			952	953	964	986	1,241
	B. Quilcene	320	414				743	940	940	940	941							
12-12B-12C	Big Beef	0							0	0	0			1,490	1,490	1,508	1,542	1,941
	Anderson	0							0	0	0							
	Dosewallips	655							655	655	657							
	Duckabush	617							617	617	619							
	HammaHamma	123							123	123	123							
	Lilliwaup	90				90			90	90	90							
	Dewatto	0				0			0	0	0							
Discovery	Snow	21										21		454		459	470	591
	Salmon	371	62									433						
Sequim	Jimmycomelatel	616											616	616		623	637	802
Totals		2,962	476	7	140	237	743	951	2,583	2,583	2,590	454	616	3,660	2,591	3,705	3,788	4,769
	Hood Canal	1,954	414											2,590	2,591	2,622	2,681	3,375
	E. Strait Portion	1,008	62											1,070		1,083	1,107	1,394

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1993**	**Harvest**		2	0	1	0	15	0	0	2	0	0		0	46	53	67
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		2		2			2	2	2			2	2	2	2	2
12D	Tahuya	0			0	0			0	0	0			252	252	261	271	284
	Union	251			251	252			252	252	252							
12A	L. Quilcene	12						13	13	13	13			163	163	169	175	183
	B. Quilcene	97	39				136	150	150	150	150							
12-12B-12C	Big Beef	0							0	0	0			353	353	365	379	397
	Anderson	0							0	0	0							
	Dosewallips	105							105	105	105							
	Duckabush	105							105	105	105							
	HammaHamma	69							69	69	69							
	Lilliwaup	72				72			72	72	72							
	Dewatto	1				1			1	1	1							
Discovery	Snow	11										11		463		479	497	520
	Salmon	400	52									452						
Sequim	Jimmycomelatel	110											110	110		114	118	124
Totals		1,233	91	2	251	327	136	163	769	769	771	463	110	1,344	771	1,389	1,442	1,509
	Hood Canal	712	39											771	771	797	827	866
	E. Strait Portion	521	52											573		592	615	644

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1994**	**Harvest**		1	0	0	0	20	0	0	13	0	0		0	26	54	451
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		1		1			1	1	1			1	1	1	1	1
12D	Tahuya	0			0	0			0	0	0			742	742	749	765	892
	Union	738			738	738			738	738	742							
12A	L. Quilcene	0						0	0	0	0			744	744	751	767	894
	B. Quilcene	349	373				722	742	742	742	744							
12-12B-12C	Big Beef	0							0	0	0			968	968	978	998	1,164
	Anderson	0							0	0	0							
	Dosewallips	225							225	225	226							
	Duckabush	263							263	263	264							
	HammaHamma	370							370	370	372							
	Lilliwaup	105				105			105	105	106							
	Dewatto	0				0			0	0	0							
Discovery	Snow	2										2		163		165	168	196
	Salmon	137	24									161						
Sequim	Jimmycomelatel	15											15	15		15	15	18
Totals		2,204	397	1	738	844	722	742	2,444	2,444	2,455	163	15	2,633	2,455	2,660	2,714	3,165
	Hood Canal	2,050	373											2,455	2,455	2,480	2,530	2,951
	E. Strait Portion	154	24											178		180	183	214

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1995**	**Harvest**		0	0	0	0	7	0	0	32	0	0		0	0	68	458
														Management Unit				
			Brood		**********		Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		0		0			0	0	0			0	0	0	0	0
12D	Tahuya	0			0	0			0	0	0			723	723	723	728	760
	Union	721			721	721			721	721	723							
12A	L. Quilcene	54						54	54	54	54			4,589	4,589	4,589	4,619	4,822
	B. Quilcene	4,029	491				4,520	4,527	4,527	4,527	4,535							
12-12B-12C	Big Beef	0							0	0	0			4,181	4,181	4,181	4,209	4,394
	Anderson	0							0	0	0							
	Dosewallips	2,787							2,787	2,787	2,796							
	Duckabush	825							825	825	828							
	HammaHamma	476							476	476	478							
	Lilliwaup	79				79			79	79	79							
	Dewatto	0				0			0	0	0							
Discovery	Snow	25										25		616		616	620	647
	Salmon	538	53									591						
Sequim	Jimmycomelatel	223											223	223		223	224	234
Totals		9,757	544	0	721	800	4,520	4,581	9,469	9,469	9,493	616	223	10,332	9,493	10,332	10,400	10,858
	Hood Canal	8,971	491											9,493	9,493	9,493	9,556	9,977
	E. Strait Portion	786	53											839		839	845	882

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1996**	**Harvest**		35	0	0	0	51	24	24	40	0	0		0	23	80	338
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		35		35			35	35	35			35	35	35	35	36
12D	Tahuya	5			5	5			5	5	5			501	501	502	503	511
	Union	494			494	494			495	495	496							
12A	L. Quilcene	265						266	267	267	267			9,597	9,597	9,607	9,643	9,792
	B. Quilcene	8,479	771				9,250	9,300	9,310	9,321	9,330							
12-12B-12C	Big Beef	0							0	0	0			10,544	10,544	10,555	10,594	10,758
	Anderson	0							0	0	0							
	Dosewallips	6,976							6,984	6,992	7,005							
	Duckabush	2,650							2,653	2,656	2,661							
	HammaHamma	774							775	776	777							
	Lilliwaup	40	60			100			100	100	100							
	Dewatto	0				0			0	0	0							
Discovery	Snow	160										160		1,054		1,055	1,059	1,075
	Salmon	785	109									894						
Sequim	Jimmycomelatel	30											30	30		30	30	31
Totals		20,658	940	35	499	634	9,250	9,566	20,624	20,647	20,678	1,054	30	21,762	20,678	21,785	21,865	22,202
	Hood Canal	19,683	831											20,678	20,678	20,700	20,776	21,097
	E. Strait Portion	975	109											1,084		1,085	1,089	1,106

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1997**	**Harvest**		0	0	77	0	100	3	0	0	0	0		0	0	46	198
														Management				
			Broo	**********			Run Abundance by Location				**********				Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		0		0			0	0	0			0	0	0	0	0
12D	Tahuya	0			0	0			0	0	0			482	482	482	484	493
	Union	410			410	481			482	482	482							
12A	L. Quilcene	29						29	29	29	29			8,006	8,006	8,006	8,042	8,199
	B. Quilcene	7,339	535				7,874	7,974	7,976	7,976	7,976							
12-12B-12C	Big Beef	0							0	0	0			664	664	664	667	680
	Anderson	0							0	0	0							
	Dosewallips	47							47	47	47							
	Duckabush	475							475	475	475							
	HammaHamma	104							104	104	104							
	Lilliwaup	10	16			31			31	31	31							
	Dewatto	6				7			7	7	7							
Discovery	Snow	67										67		901		901	905	923
	Salmon	724	110									834						
Sequim	Jimmycomelatel	61											61	61		61	61	62
Totals		9,272	661	0	410	519	7,874	8,003	9,151	9,151	9,151	901	61	10,113	9,151	10,113	10,159	10,357
	Hood Canal	8,420	551											9,151	9,151	9,151	9,193	9,372
	E. Strait Portion	852	110											962		962	966	985

Reconstruction of the HC-SJF Summer Chum Salmon Runs

Year:	**1998**	**Harvest**		5	21	0	0	10	0	0	0	0	0		0	0	41	98
														Management Unit				
			Brood		**********			Run Abundance by Location				**********			Seattle	Admiralt	US	Canadi
Mgmt Unit	Prod. Unit	Escapement	stock	82G/J	12D	12C	82F	12A	12B	12	9A	Discov	Sequi	Term.	(Area	(Area 9)	Conv.	Area
Skokomish	Skokomish	N/A		5		5			5	5	5			5	5	5	5	5
12D	Tahuya	0			0	0			0	0	0			244	244	244	246	250
	Union	223			244	244			244	244	244							
12A	L. Quilcene	265						266	266	266	266			3,066	3,066	3,066	3,090	3,146
	B. Quilcene	2,244	547				2,791	2,800	2,800	2,800	2,800							
12-12B-12C	Big Beef	0							0	0	0			741	741	741	747	760
	Anderson	0							0	0	0							
	Dosewallips	336							336	336	336							
	Duckabush	226							226	226	226							
	HammaHamma	143							143	143	143							
	Lilliwaup	4	20			24			24	24	24							
	Dewatto	12				12			12	12	12							
Discovery	Snow	28										28		1,172		1,172	1,181	1,203
	Salmon	1,023	121									1,144						
Sequim	Jimmycomelatel	98											98	98		98	99	101
Totals		4,602	688	5	244	285	2,791	3,066	4,056	4,056	4,056	1,172	98	5,326	4,056	5,326	5,367	5,466
	Hood Canal	3,453	567											4,056	4,056	4,056	4,087	4,162
	E. Strait Portion	1,149	121											1,270		1,270	1,280	1,303

Appendix Report 1.4
Summary of SASSI Definitions And Criteria

The following material describes the approaches and methods used in the 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI); developed by the Washington Department of Fisheries, Washington Department of Wildlife, and Western Washington Indian Tribes. For a more detailed treatment of the SASSI process see WDF et al. (1993), and additionally, a more complete discussion of the application of genetic stock identification techniques is presented in pages 13-15 of WDFW et al. (1994).

Stock Definition

The first task in developing salmonid resource inventories is to arrive at a meaningful definition of the units of fish on which to base the assessment. Stocks were chosen as the basis for SASSI for several reasons. They provide the finest resolution of all the units considered and allow assessment of larger units by combination; stocks form the basic building blocks of Northwest salmonid management, and stock units are widely accepted within the scientific community as a basis for evaluating fish populations.

The definition of the term "stock" and its application frequently present difficulties because the distinctions between different groups of organisms are often difficult to measure, and because the term is used for a variety of purposes. For example, as applied in bottomfish management, a stock is a group of fish that exhibits a homogeneous response to fishing effort in an area, and may be made up of several breeding populations, or be part of a population. However, in salmonid management a stock is generally considered a discrete breeding population. Ricker (1972) defined salmon stocks as temporally or spatially separated breeding populations. The Puget Sound Salmon Management Plan refers to the fish of a single species that migrate at a particular season to a specific hatchery or independent river system as a stock. For the purpose of this inventory the authors of SASSI adopted the following definition which is essentially the same as that proposed by Ricker.

> **SASSI STOCK DEFINITION: The fish spawning in a particular lake or stream(s) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place at a different season.**

It should be noted that some differing views likely will surround any specific definition of stock. The inventory did not attempt to resolve these views or their applications. The purpose of the SASSI definition is simply to provide a clear, consistent and meaningful basis for conducting an inventory of the salmonid resources in Washington, and does not imply that this definition should be applied for other uses, that even smaller units of production are unimportant, or that the management of

fisheries or fish habitat should be on this basis. Where reproductive isolation was shown or presumed to exist in the inventory, it may or may not indicate genetic uniqueness from other stocks. The terms stock and spawning population are used synonymously in the inventory.

Even with SASSI's basic stock definition, considerable uncertainty often occurs in applying it to any specific spawning group because limited direct data exist to evaluate the degree of reproductive isolation among spawning groups. Fish management entities have inventoried fish populations annually as an integral part of the management process. Data collection programs focus primarily on gathering information necessary to manage various salmonid fisheries. Consequently the detailed information needed to identify and evaluate Washington's wild stocks is often quite limited. This lack of detailed data has imposed some restrictions on the development and use of the inventory. It is impossible to ensure that SASSI accurately defines all wild salmonid stocks in the state. Many stocks listed in this inventory have not been studied in enough detail to be designated as discrete stocks with great certainty. Many others need more refined data to determine whether observed differences in timing or distribution actually represent stock differentiation. The inventory must be viewed as a starting point, and its list of stocks should be expected to evolve with future updates. The stock inventory process will continue to be conducted and, as more information is assembled, stocks will be added or deleted based on additional information.

The SASSI process emphasizes naturally-reproducing stocks of salmonids regardless of origin (native, non-native and mixed parentage). Future reports may include hatchery stocks as well. Only those stocks that spawn within Washington State are included. Past extinctions are not included in the status assessment because it is a current resource inventory, and the historic information on lost stocks is incomplete and often anecdotal. Where reliable information is available, reference may be made to extinctions in general terms in introductory sections only.

Stock Definition Criteria

The criteria for defining stocks are:

Distinct spawning distribution.

Distinct temporal distribution (including spawning or run-timing).

Distinct biological characteristics (e.g. size, age structure, gene frequency differences, etc.)

Each of these criteria is an attribute that can be used to determine whether a group of fish is displaying substantial reproductive isolation. A population meeting any one of the above criteria is initially classified as a SASSI stock until additional information shows that it should not be considered distinct. The term distinct is not intended to imply complete isolation from other stocks. The SASSI stock definition recognizes that some interchange between populations is a natural part of salmonid biology.

Distinct spawning distribution is the most commonly used criterion for identifying individual stocks in the SASSI process because general information on the geographic location of spawning and

spawning habitat is the most readily available. However, spawning distribution often does not show distinct separation and can be difficult to assess. A number of factors must be considered such as: degree of isolation, interchange between spawning groups, and the relationships between spawners in adjacent streams. It is also difficult to measure directly because it requires that spawning distribution of several generations of fish be tracked (i.e., do offspring of each generation return to spawn in the same areas that are substantially separated from areas used by other spawning groups). This criterion must usually be assumed since empirical data are often unavailable and are difficult to collect.

Distinct temporal distribution identifies stock differences based on variations in timing of critical life stages (e.g., spawn timing). Such differences are sometimes very distinct with no overlap between adjacent stocks. Differences are then generally quite obvious and easy to assess from readily-collected information. Many cases occur, however, where timing does overlap, and the difference between within-stock variation and distinct stocks becomes less clear.

Distinct biological characteristics can include any observable distinctions between stocks in size, color, age structure, scale patterns, parasites, or genetic differences. For some stocks, the stock differentiation is based on observable physical attributes. An example would be the distinction between tule and bright fall chinook from the upper Columbia River. These two types of chinook exhibit differences in spawning timing, but can also be characterized by differences in skin and flesh color. In this case, tule and bright fall chinook are designated as separate stocks based on both spawning timing and biological characteristics.

Genetic distinctions are the most common biological characteristic used in the inventory. There are indirect and direct approaches in SASSI for using genetic characterizations to distinguish among stocks. The indirect approach assumes that in some cases the genetic makeup of a group of fish has been substantially changed by past or continuing introductions of non-native stocks. If these introductions represent a major impact on the native gene pool, it is sometimes assumed that the resulting fish are probably hybridized and are a single genetic stock. In some areas, the introduction of hatchery origin fish (in particular chinook and coho salmon) has impacted the genetic character of stocks in a region which includes several streams, and it is assumed that the impact of these releases has resulted in one genetic stock.

The direct approach is based on genetic stock identification (GSI), which is a method that can be used to characterize populations of organisms using the genetic profiles of individuals. The GSI methodology relies on the combined use of biochemical, genetic, and statistical procedures to discriminate among populations. While the GSI characterization of stocks and testing of stock structure provide a direct measure of genetic interrelationships, it is important to be aware of this approach's limitations. Geneticists can investigate only a tiny and restricted fraction of the genetic traits of salmonids by the electrophoretic analysis of proteins. To the extent that characteristics investigated do not represent the entire genome, the view of genetic interrelationships could be incomplete. Also, while statistically significant differences among samples provide evidence for the existence of distinct gene pools (i.e. separate stocks), the absence of significant differences does not constitute proof that only a single stock exists.

The Stock Identification Process

To arrive at a preliminary list of stocks, biologists identify individual stocks based on the first two criteria; known differences in spatial or temporal distribution. These distinctions are difficult to determine in some cases, particularly in situations where the amount of interchange among adjacent groups of fish was unknown. This preliminary list of stocks is then examined using available information on unique biological characteristics (principally genetic stock identification data). This review can result in a number of changes to the stock list, where additional groups of fish are identified based on observed genetic differences or other biological characteristics. More detailed analysis during future inventories likely will change some stock designations.

Stock Origin

An understanding of the genetic background of salmonid stocks in Washington State is important for the development of any future efforts to restore and maintain these resources. Regardless of species, the SASSI process recognizes three categories of stock origin: 1) those stocks of fish that are thought to represent native gene pools, 2) those stocks that resulted from the introductions of non-native fish, and 3) those stocks that are a mix of native and non-native fish, or are substantially genetically altered native fish. A great deal of uncertainty often exists about the genetic histories of many salmon and steelhead stocks, and the contributions of hatchery-origin salmonids to native Washington populations have not been rigorously evaluated.

The definitions for stock origin used in SASSI are:

Native -- An indigenous stock of fish that has not been substantially impacted by genetic interactions with non-native stocks, or by other factors, and is still present in all or part of its original range. In limited cases, a native stock may also exist outside of its original habitat (e.g., captive brood stock programs).

Non-native -- A stock that has become established outside of its original range.

Mixed -- A stock whose individuals originated from commingled native and non-native parents, and/or by mating between native and non-native fish (hybridization); or a previously native stock that has undergone substantial genetic alteration. This may include species cross such as hybrids between cutthroat and steelhead, or rainbow trout.

Unknown -- This description is applied to stocks where there is insufficient information to identify stock origin with confidence.

Production Type

The inventory describes the naturally-reproducing salmonids in the state. The origin of a stock or stock refers only to the genetic background of that specific group of fish. To understand more about the nature of an individual stock, it is also necessary to describe the type of spawning and rearing that produced the fish. For example, a stock of fish may be a genetic mixture of native and non-native fish, but in the absence of continuing hatchery releases, the stock may be self-sustaining as the result of natural spawning and rearing. These fish would be identified as a stock with a mixed origin and a wild production type. A native stock of fish in a rehabilitation program also can be sustained entirely by fish culture techniques. This situation is typified by Baker River sockeye salmon, a stock that is currently being restored by placing most spawners in an artificial spawning beach. This stock would be characterized as a native stock with a cultured production type.

The terms defining production type are:

Wild -- A stock that is sustained by natural spawning and rearing in the natural habitat, regardless of parentage (includes native).

Cultured -- A stock that depends upon spawning, incubation, hatching, or rearing in a hatchery or other artificial production facility.

Composite -- A stock sustained by both wild and artificial production.

Stock Status

Once the stocks are identified, the current status of each is assessed based primarily on trends in fish population size or spawner abundance, or survival. Detailed abundance data for individual stocks are sometimes not available.

A two-step process is used to evaluate the status of the state's salmonid stocks. First, five separate criteria (see the Stock Screening section below for a description of these criteria) were developed to describe changes in stock status and fitness, and each stock is screened to identify negative changes in abundance, production or survival. Stocks that met none of the criteria and are judged to be experiencing production levels within natural variations in survival and consistent with their available habitat were rated as "Healthy." Second, any stock that met one or more of the five negative performance criteria is examined further and subsequently rated in Depressed or Critical status categories to identify the probable level of damage suffered by the stock. An "Unknown" category is used for stocks if trend information is unavailable or could not be used to assess stock status.

There are several circumstances that complicate the rating process. When a wild stock experiences an extremely low survival, it is sometimes difficult to know if that survival is within the normal range for the stock, or if it is entering a depressed state caused by human impacts (e.g., habitat destruction or over-fishing). Naturally-produced salmonid stocks exhibit wide variations in survival, caused in part by changes in freshwater stream flows (droughts and flooding), ocean conditions (e.g.,

El Niño events) and biological interactions such as competition and predation (Cooper and Johnson 1992). It is not uncommon for wild stocks to experience one or two extremely low survival years each decade, resulting in low adult returns. This type of natural variation also provides years of above average production.

Some stocks are experiencing survivals that are so low that they are clearly below the level of natural variation. The survivals of other stocks are intermediate between obviously healthy stocks and clearly depressed stocks and are the most challenging to evaluate because they could be experiencing low survivals within the normal range for the stock. Short-term databases often exacerbate the rating problem because with only a few years of observation it is unlikely that the lowest natural survivals have been documented. The evaluation of stocks with intermediate survivals was based on the collective judgment of technical agency staff members most familiar with each stock.

The possibility of cycling in the survival rates of various stocks also can create difficulty in rating stock status. These cycles may be associated with weather-related impacts on freshwater spawning and rearing success. The apparent existence of cycles in survival and production data complicates the task of identifying depleted stocks, since poor stock performance could be the result of natural cyclic variation. Wherever possible, the existence of survival cycles is considered during the stock evaluation process and stocks with production levels within normal ranges of variation (including cyclic variation) are rated healthy.

Stock Screening

The best available escapement, population size, and survival data are used to screen each stock for indications of negative production or survival trends. Only stock-specific data are used, which sometimes limits the available data to a short span of recent years. These data are plotted and qualitatively examined for changes in abundance or survival. Often, only a single stock-specific statistic is available to analyze the production trend of a stock. When multiple types of data can be used to examine individual stock status, the available production or survival data sets are examined individually, and each stock's rating is based on the data that best described current status.

Five stock screening criteria were developed and are used in the initial evaluation of each stock for trends in survival, escapement, or production. These criteria do not currently incorporate quantitative formulas because the available stock specific information is often too limited for statistical evaluation. More subjective criteria were applied, and decisions are based on the collective judgment of the technical reviewers most familiar with each stock. While this approach likely can be improved in the future with additional and better information, it facilitates the initial stock status classification process. The status of each stock will be subject to ongoing review and refinement in subsequent inventories.

The five stock screening criteria are:

Long-Term Negative Trend -- This criterion reflects ten years of data showing a consistent drop in a survival or production parameter. The negative trend is the important factor and several high values would not eliminate a stock from being categorized under this criterion. Most

Washington salmon and steelhead escapement and production data bases span periods of ten to twenty-five years.

Short-Term Severe Decline -- A short-term drop in escapement or production is often difficult to distinguish from the amount of natural variation displayed by all naturally produced stocks of fish. It is important, however, to attempt to identify declining stocks as early as possible, so that limiting factors can be recognized and, if possible, corrected before serious damage occurs. The most recent five years of production data were examined for evidence of any significant drop in escapement, population size, or survival. If two of the five years display significant production decreases, the stock is included in this category.

Chronically Low -- Stocks in this category are sustaining themselves at levels significantly below their potential. The determination that a stock is chronically low may be based on observed past production levels, or on an assessment that stock performance does not meet expected levels based on available habitat. Chronically low stocks may display declining, stable, or even increasing trends. For stocks that have displayed chronically low production for an extended period, it may be necessary to examine any available data for the years before current stock assessment databases were developed.

Decreases In Fitness -- The ability of wild salmonid stocks to sustain themselves can be significantly affected by changes in the fitness of the individuals that make up a given stock. These changes can be subtle and include factors like changes in adult size or age structure, inbreeding associated with small numbers of spawners, changes in spawn timing, or other reduction in genetic variability. Any significant changes in fitness may justify the inclusion of a stock in this category. Currently no information is included in the inventory that allows any quantitative assessment of change in fitness.

Unknown -- Many salmonid stocks have not been monitored or enumerated over a sufficient period of years to enable determination of status. Stocks in this category will have an Unknown status rating. Evaluation of their status for future inventories will require more intensive stock assessment work.

Stock Status Rating

The stock-screening process is used to place stocks into five status categories. Stocks with escapement, population size or survival levels within normal ranges are rated as Healthy. Those stocks that currently display low production or survival values are assigned to one of two separate rating categories: Depressed or Critical, depending on the current condition of the stock. Stocks are also rated as Unknown when data limitations did not allow assessment of current status. A rating category for Extinct stocks is also included. Definitions and discussions of each of these rating categories are provided below.

The rating of stock status was done during a technical review process. The amount and quality of stock data vary among regions within the state, which can result in some differences in the application of the rating categories. These ratings represent the collective judgment of the technical staff most familiar with the individual stocks. The iterative nature of the inventory process will

allow these ratings to be changed in the future as more detailed information becomes available, or because of changes in stock status.

Healthy Stocks

> **Healthy** -- A stock of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock.
>
> Healthy stocks are those currently experiencing stable escapement, survival, and production trends and not displaying a pattern of chronically low abundance. Because wild salmonid stocks experience large natural fluctuations in survival (caused by environmental variations), it is not unusual for even the most robust stock to experience occasional low abundance or even fail to meet escapement goals. Such fluctuations would not necessarily warrant a change in status unless the stock experiences a consistent declining trend, or a sudden significant drop in production. The Healthy category covers a wide range of stock performance levels, from consistently robust production to those stocks that may be maintaining sustainable levels without providing any surplus production for directed harvests. In other words, the fact that a stock may be classified as Healthy in the inventory process does not necessarily mean that managers have no current concerns about its production status. State and tribal fishery managers believe very strongly that habitat protection and restoration needs exist for many of the stocks classified as Healthy in SASSI as well as for Critical and Depressed stocks. In addition, due to a lack of information on changes in fitness, some stock were classified as Healthy that may have been significantly influenced by interactions with non-native species. Much current resource management activity focuses on resolving problems for productive stocks to ensure they remain healthy and continue to provide harvest opportunity.

Approaches to considering habitat degradation, or loss, in assessing the status of individual stocks presents a particularly difficult problem. It is probable that all wild salmonid stocks in Washington State have been affected by some level of habitat loss. It might be argued that if a stock has suffered any habitat loss, it cannot be judged to be Healthy. Such an argument is unrealistic, but it would still be desirable to identify some level at which the cumulative impacts of habitat loss have taken a stock out of the Healthy category. Unfortunately, it is difficult to accomplish this task, because individual stocks are faced with such a wide range of different habitat impacts. The SASSI report rates the current status of each stock based primarily on trends in survival rates and population size, and does not focus directly on causative factors. Habitat loss, over-fishing, or other factors, may be the reason that a stock is Depressed or Critical, but the rating is based on actual stock performance.

The consideration of available habitat is included in the stock rating definitions for Healthy and Depressed stocks. This approach is an effort to recognize that there have been irreversible losses of habitat and that if stock status were rated against a pristine habitat base, virtually every stock could be rated depressed or worse. Such a result would be of little help in addressing the current need to restore our wild salmonid stocks. To provide a meaningful assessment of current stock status, a flexible definition of "available" habitat is needed. In SASSI, "available" habitat may be habitat that is currently accessible to wild salmonids or in some cases may include all habitat that salmonids could reasonably be expected to utilize, even if currently inaccessible. For example, if a stock lost

access to and/or was blocked from utilizing a substantial proportion of the available habitat in a stream, this may have been considered in the rating of stock status.

This definition is not meant to imply that a stock rating will remain healthy in the face of continuing habitat loss, even if the stock remains in balance with declining habitat. Future inventories will identify those Healthy stocks that are in need of attention to help ensure they remain at healthy levels. SASSI will also serve as a baseline against which any future changes in stock performance or habitat availability can be measured.

Depressed Stocks

Depressed -- A stock of fish whose production is below expected levels based on available habitat and natural variations in survival rates, but above the level where permanent damage to the stock is likely.

The category of Depressed stocks is used to identify those stocks that are experiencing difficulties that contribute to lower than expected abundance. These stocks meet one or more of the negative performance criteria, but are likely above the level where permanent damage has occurred to the stock. These stocks may currently be producing relatively large numbers of fish but have experienced a substantial drop in production or are producing well below their potential. Other stocks may be represented by relatively small numbers of individuals and are chronically depressed; forced to a low production level by some combination of biological, environmental, or human-caused factors. It is not unusual for a stock to stabilize at a low production level by achieving a balance with the particular set of survival pressures controlling its success. While Depressed stocks may not immediately be pushed to Critical status or face extinction, they are vulnerable to any additional negative impacts and can potentially change status very rapidly. Additionally, these stocks often constrain fishery harvest opportunity because of their low abundance.

Critical Stocks

Critical -- A stock of fish experiencing production levels that are so low that permanent damage to the stock is likely or has already occurred.

The Critical stock category is reserved for those stocks that have declined to a level where the stock is in jeopardy of significant loss of within-stock diversity or, in the worst case, could face extinction. The loss of within-stock diversity includes such factors as a reduction of range (e.g., spawning and/or rearing distribution), shifts in age at maturity, changes in body size, reduction in genetic variability, or lowered disease resistance. Major shifts in these or other attributes can all lead to significant reductions in a stock's ability to respond to changing conditions. The usual result is reduced survival and population size. Such stressed stocks can be caught in a downward spiral of ever-increasing negative impacts that can lead to eventual extinction. In contrast, stocks in this category might reach an equilibrium with those factors controlling their performance and could display consistent population size and escapements for an extended period. While such stocks would appear to be stable, they could be delicately balanced, awaiting just one additional

negative impact to push them into failure. The Critical stocks are in need of immediate restoration efforts to ensure their continued existence and to return them to a productive state.

Unknown Stocks

Unknown -- There is insufficient information to rate stock status.

If sufficient trend information is not available or can not be used to assess status, stocks are rated as Unknown. Stocks rated as Unknown may be rated as Healthy, Depressed, Critical, or Extinct once more information is available. It is not known to what extent the Unknown stocks represent historically small populations. There is an immediate need to collect information on Unknown stocks. Historically small populations or currently small populations could be especially vulnerable to any negative impacts.

Extinct Stocks

Extinct -- A stock of fish that is no longer present in its original range, or as a distinct stock elsewhere. Individuals of the same species may be observed in very low numbers, consistent with straying from other stocks.

The SASSI process identifies extant salmonid stocks and makes no effort to identify and assess past extinctions. The past loss of stocks is an important historical fact that challenges resource management effectiveness. It would be difficult, however, to assemble any kind of comprehensive listing of past extinctions because many of these losses occurred prior to the time that enumeration programs were initiated. Since SASSI is an inventory of the current status of wild salmonid stocks, the inclusion of known past extinctions was not emphasized. The Extinct rating is included here to identify any current and future losses of stocks identified during the inventory process. The Extinct category is applied in the inventory if a stock that is currently being tracked in escapement or fishery management data bases is found to have been extirpated within its native range.

References

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Appendix Report 1.5
Derivation of Critical Status Thresholds for Management Units and Escapement Distribution and Minimum Escapements Flags for Stocks

It is necessary to annually evaluate the abundance (total return) and the escapement of the summer chum salmon of the region to ensure that timely adaptive management will occur if recovery objectives are not met. However, reliable data do not currently exist on the age composition of summer chum stocks and on the distribution of harvest among the stocks of summer chum. Thus, it is not possible to develop stock specific spawner/recruit functions for use in evaluating specific fisheries effects for individual management units or stocks. This limits the fisheries managers' ability to assess incidental harvest impacts on the summer chum of the management units and stocks.

Because of these data limitations, the Base Conservation Regime is designed to be conservative in its approach and is believed to be sufficient to protect summer chum stocks for all immediately foreseeable conditions (see section 3.5.6.1 for a description of the specific conduct of fisheries). However, to ensure the protection and restoration of individual stocks, and also to ensure the health and diversity of Hood Canal and Strait of Juan de Fuca summer chum as a whole, specific criteria have been developed to serve as critical thresholds (or flags) to identify individual management units and stocks that may be performing poorly. In a post-season review, annually estimated abundances (total adult recruitments) and escapements are compared with the critical status[1] thresholds and flags to assess the status of individual management units and stocks. Also, in preparation for the next fishing season, the forecast run sizes and their parental brood run sizes and escapement are reviewed. If the estimated population parameters fall below the thresholds, or flags, then additional management measures beyond those provided in the Base Conservation Regime may be warranted. The application of these thresholds and flags is described in sections 1.7.3, 3.5.7.1 and 3.6.4, and their derivation is described below.

Critical Thresholds for Management Units

The critical management unit thresholds for abundance and escapement are based on the lowest levels observed in the historical data. A "buffer" is added to the lowest observed values to obtain the thresholds. The "buffers" were determined as follows. First, the annual recruit abundances of each management unit, including all currently existing stocks, were examined for statistical outliers (using Hadi outlier detection procedure of SYSTAT, version 9.0). This procedure was applied to all summer chum salmon management units for return years from 1974 through 1998 (25 years). Exceptions were made for the Discovery Bay

1 Note that "critical status" in the context used here has a different definition (as described in section 1.7.3 and in detail within this appendix) than the critical definition for SASSI stocks (shown in section 1.7.2).

and Quilcene/Dabob Bay management units, where the years 1995-1998 were excluded (leaving a total of 21 years) because of substantial adult returns in that time period from summer chum supplementation projects.

The highest two detected abundance outliers of each management unit were removed with two exceptions. In the Discovery Bay Management Unit, only one outlier was found and removed, while in the Mainstem Hood Canal Management Unit (12B), three outliers were removed because there was no significant difference between the second and third detected outliers.

Once the abundance outliers were removed, the "buffer" was calculated for each management unit as 25% of the range between the minimum and maximum abundance values. (The exception is Discovery Bay where 20% of the range was used because of the distribution of the abundance values.) As indicated previously, the calculated "buffer" was added to the lowest abundance value of each management unit to obtain each critical abundance threshold level. The critical escapement threshold levels were then calculated by multiplying each abundance threshold by the estimated escapement rate for each management unit. (The escapement rate was calculated by subtracting the Base Conservation Regime's estimated by-catch rate for each management unit from 1.0.) Data used and results of this procedure are shown in Appendix Table 1.5.1. The results are summarized as follows (values rounded to nearest 10):

Management Unit	Critical Abundance Threshold	Critical Escapement Threshold
Sequim Bay	220	200
Discovery Bay	790	720
Mainstem Hood Canal	2,980	2,660
Quilcene/Dabob	1,260	1,110
SE Hood Canal	340	300
Total	5,590	4,990

Escapement Distribution Flags and Minimum Escapement Flags within the Mainstem Hood Canal Management Unit

Each management unit currently corresponds to one summer chum stock with the exception of the Mainstem Hood Canal Management Unit, in which four individual stocks are represented. The Mainstem Hood Canal Management Unit's thresholds (described above), provide criteria for assessing the management unit as a whole but do not address the possibility of poor performance by its individual stocks. For example, in a given year, one or more stocks within the Mainstem Hood Canal Management Unit may have a dangerously low escapement level that is not detectable by the management unit's threshold because other stocks in the unit may have a relatively high escapement level.

To address this problem, specific criteria were developed to detect when significant deviations occur from the expected distribution of escapement among the Mainstem Hood Canal Management Unit's stocks, and to assist in determining when an individual stock's escapements fall below a critical level. These criteria are respectively called escapement distribution flags and minimum escapement flags.

The escapement distribution flags were computed in the following manner. The average proportional contribution of each stock to the Mainstem Hood Canal Management Unit was calculated for the period of 1974 through 1980. Then, for each stock, one standard deviation was subtracted from the average contributed proportion to arrive at the value that would serve as the escapement distribution flag for that stock. The computation of the escapement distribution flag is shown in the following equation.

$$\text{Escapement Distribution Flags} = \left[\frac{\sum_{x=1974}^{1980} \left[\frac{\text{Escapement}_s}{\text{Escapement}_{HCMMU}} \right]}{N} \right] - \left[\text{Standard Deviation of Average} \right]$$

where,

S	=	stock within the Hood Canal Mainstem Management Unit
HCMMU	=	Hood Canal Mainstem Management Unit
N	=	number of years between 1974-1980

The years 1974 through 1980 were used in the above computation because that was a period of relatively high abundance prior to the decline of the 1980s, and there was relatively stable distribution of escapements among the stocks within the Mainstem Management Unit. It was assumed that setting the flag one standard deviation below the average proportion of escapement would provide adequate detection of potentially dangerous deviation from the historical distribution pattern.

The minimum escapement flags were calculated by simply multiplying the above described average escapement proportions for each stock by the critical escapement threshold for the Mainstem Hood Canal Management Unit as shown in the following equation.

$$\text{Minimum Escapement Flag}_s = \left[\text{Critical Escapement Threshold}_{HCMMU} \right] \times \left[\text{Average 1974-1980 proportion}_s \right]$$

where,

HCMMU	=	Hood Canal Mainstem Unit
S	=	individual stock within HCCMU

It was assumed that the minimum escapement flags, based on the Mainstem Hood Canal Management Unit's threshold and the escapement distribution of the individual stocks, would provide adequate detection of dangerously low escapements for each stock.

The immediately following table describes for each Mainstem Hood Canal Management Unit stock, the mean proportion of escapement in the non-critical years of 1974 through 1980, the standard deviation, the escapement distribution flag and the minimum escapement flag.

Critical Status Flags for Individual Stocks of the Hood Canal Mainstream Unit

Stock	Mean Proportion in non-Critical Years	Sample Standard Deviation	EDF	MEF
Dosewallips	0.277	0.130	0.147	736
Duckabush	0.263	0.083	0.180	700
Hamma Hamma	0.392	0.199	0.193	1,042
Lilliwaup	0.069	0.026	0.043	182
	1.000			2,660

Appendix Table 1.5.2 describes results of applying the flags to estimated stock escapements over the years 1974 through 1998. This table also shows where the Mainstem Hood Canal Management Unit's total escapements were above and below the critical escapement threshold over the same years.

How the Mainstem Management Unit threshold and escapement flags function when they are applied to abundances and escapements of past years is shown in Appendix Table 1.5.2. The results of these applications demonstrate how the critical thresholds and the EDFs work together to ensure that a flag will be raised whenever the Hood Canal Mainstem Management Unit, or the stocks within it, experience severe abundance or escapement problems. They also demonstrate that the method used to derive the EDFs is conservative. EDFs are triggered in some years, but a closer examination reveals escapements to some stocks were, in fact, sufficient. Given the conservativeness of the approach, the triggering of an EDF requires an evaluation of the associated stock(s), but does not mandate that action be taken if it can be shown that the additional actions are not necessary (see section 3.6.1).

Appendix Table 1.5.1. Hood Canal and Strait of Juan de Fuca summer chum salmon escapements (1974-98) used to calculate critical thresholds for management unit abundance and escapement.

Run Year	Discovery			Sequim			Strait of Juan de Fuca			Mainstem HC			Quilcene			SE HC			Hood Canal			ESU		
	Esc	Harv	Total	Esc	Harv	Total	Esc	Harv	Total	Esc	Harv	Total	Esc	Harv	Total	Esc	Harv	Total	Esc	Harv	Total	Esc	Harv	Total
1974	1,330	164	1,494	438	54	492	1,768	218	1,986	10,23	1,284	11,52	839	105	944	68	9	77	11,14	1,398	12,54	12,91	1,616	14,529
1975	1,082	278	1,360	348	20	368	1,430	298	1,728	8	3,673	2	2,273	962	3,235	84	130	214	5	4,765	3	3	5,063	21,392
1976	1,129	135	1,264	365	44	408	1,494	179	1,672	12,54	11,01	16,21	3,533	7,673	11,20	100	563	663	14,89	19,24	19,66	16,32	19,42	43,181
1977	1,239	125	1,364	405	41	446	1,644	166	1,810	2	3	5	1,594	324	6	75	167	242	9	9	4	9	8	14,020
1978	2,293	120	2,413	787	41	828	3,080	161	3,240	18,62	2,287	29,63	4,794	760	1,918	64	75	139	22,25	2,778	41,50	23,75	2,944	25,739
1979	591	108	699	170	31	201	761	140	900	6	3,460	9	455	279	5,554	97	273	370	9	4,295	8	3	4,455	9,417
1980	3,783	344	4,127	1,326	121	1,447	5,109	465	5,574	7,763	1,773	10,05	529	1,403	734	208	939	1,147	9,432	2,326	12,21	11,07	2,465	16,532
1981	681	198	879	203	59	261	884	257	1,140	13,34	5,260	0	222	539	1,932	41	67	108	18,20	7,602	0	6	8,067	6,043
1982	2,153	619	2,771	599	172	771	2,751	791	3,542	6	2,195	16,80	281	1,214	761	153	459	612	4	2,801	22,49	21,28	3,057	11,090
1983	885	61	946	254	18	272	1,139	79	1,218	5,639	3,359	6	240	2,067	1,495	170	228	398	6,191	5,032	8	3	5,823	4,433
1984	1,212	99	1,311	367	30	397	1,579	129	1,708	2,619	159	7,412	143	1,343	2,307	194	96	290	3,356	2,453	8,517	6,952	2,532	4,666
1985	171	133	304	61	47	108	232	180	412	1,839	315	7,879	45	981	1,486	334	706	1,040	2,102	1,754	10,95	8,465	1,882	4,186
1986	795	95	890	292	35	327	1,087	130	1,217	2,082	1,120	4,034	27	1,456	1,026	1,892	2,827	4,719	2,516	2,806	8	2,986	2,986	8,651
1987	1,527	146	1,673	464	44	508	1,991	190	2,181	352	728	5,441	79	2,640	1,483	497	373	870	762	5,012	4,903	5,267	5,141	5,902
1988	2,638	313	2,951	1,052	125	1,177	3,690	438	4,128	868	53	511	297	2,244	2,719	629	114	743	1,205	3,066	7,548	1,901	3,256	9,575
1989	215	226	441	173	182	355	388	407	795	589	290	1,183	2	1,600	2,541	450	1,686	2,136	968	2,648	3,215	2,784	3,086	5,137
1990	278	153	431	63	35	98	341	188	529	504	468	1,709	6	598	1,602	275	289	564	2,423	3,755	2,959	1,200	4,162	1,956
1991	184	69	253	125	47	172	309	116	425	79	117	1,232	50	1,122	604	208	105	313	655	1,004	3,774	3,510	1,192	2,561
1992	454	137	591	616	186	802	1,070	324	1,394	1,873	200	132	743	498	1,172	140	43	183	2,799	1,427	7,435	2,646	1,543	4,760
1993	463	57	520	110	14	124	573	71	644	135	456	2,163	148	35	1,241	251	33	284	587	998	3,721	6,489	1,322	1,506
1994	163	33	196	15	3	18	178	36	214	142	44	603	722	172	183	738	154	892	423	112	5,447	975	183	3,163
1995	616	31	647	223	11	234	839	43	882	451	201	259	4,574	248	894	721	39	760	709	526	4,342	764	562	10,858
1996	1,054	21	1,075	30	1	31	1,084	22	1,106	1,485	227	651	9,515	277	4,822	494	12	506	2,368	515	1,427	1,018	557	22,162
1997	901	22	923	61	1	62	962	23	985	351	258	1,941	7,903	296	9,792	410	83	493	750	547	2,136	3,438	569	10,350
1998	1,172	31	1,203	98	3	101	1,270	34	1,304	963	21	395	3,056	90	8,199	223	27	250	2,423	400	3,366	1,323	423	5,460
										4,167	31	1,164			3,146				9,462	148	862	2,601	182	
										10,50		4,394							20,50		2,949	10,30		
										0		10,75							9		9,977	1		
										652		8							8,965		21,05	21,59		
										729		673							4,008		6	3		
												760									9,365	9,927		
																					4,156	5,278		
Avg			1,280			400			1,736			5,501			2,145			721			8,666			10,402
Max			2,951			828						11,52			3,235			1,147						
Min			253			18						2			604			77						
Max-Min			2,698			810						132			2,631			1,070						
												11,39												
												0												
Buffer			540			202						2,848			658			268						
Min+Buffer=Crit Abun			793			220						2,979			1,262			345				Sum Recr	5,600	
Crit Esc. Using BCR			723			201						2,655			1,108			301				Sum Esc.	4,990	
Rounded Crit Abund.			790			220						2,980			1,260			340				Ttl ER	0.109	
Rounded Crit Esc.			720			200						2,660			1,110			300						

Appendix Table 1.5.2. Summer chum salmon escapements of the mainstem Hood Canal stocks and the occurrence of critical status flags for the years 1974-98.

	Escapements					Status and Flags					Proportions			
Year	Lilliwaup	Hamma Hamma	Duckabush	Dosewallips	MU Total	MU Status Threshold 2,660	Lilliwaup	Hamma Hamma	Duckabush	Dosewallips	Lilliwaup	Hamma Hamma	Duckabush	Dosewallips
1974	616	2,448	3,581	3,593	10,238	Above	Ok	Ok	Ok	Ok	0.060	0.239	0.350	0.351
1975	706	7,341	2,245	2,250	12,542	Crit	Ok	Ok	Ok	Ok	0.056	0.585	0.179	0.179
1976	1,612	7,648	6,095	3,271	18,626	Above	Ok	Ok	Ok	Ok	0.087	0.411	0.327	0.176
1977	420	1,675	2,453	3,215	7,763	Crit	Ok	Ok	Ok	Ok	0.054	0.216	0.316	0.414
1978	1,331	8,215	1,898	1,901	13,346	Above	Ok	Ok	Ok	Ok	0.100	0.616	0.142	0.142
1979	163	3,096	1,190	1,190	5,639	Crit	Check	Ok	Ok	Ok	0.029	0.549	0.211	0.211
1980	247	329	827	1,216	2,619	Above	Ok	Check	Ok	Ok	0.094	0.126	0.316	0.464
1981	293	926	557	63	1,839	Crit	Ok	Check	Check	Check	0.159	0.504	0.303	0.034
1982	84	801	690	507	2,082	Above	Check	Check	Check	Check	0.040	0.385	0.331	0.244
1983	18	190	80	64	352	Crit	Check	Check	Check	Check	0.051	0.540	0.227	0.182
1984	187	170	299	212	868	Above	Ok	Check	Check	Check	0.215	0.196	0.344	0.244
1985	92	231	30	236	589	Crit	Check	Check	Check	Check	0.156	0.392	0.051	0.401
1986	97	173	177	57	504	Crit	Check	Check	Check	Check	0.192	0.343	0.351	0.113
1987	32	26	12	9	79	Crit	Check	Check	Check	Check	0.405	0.329	0.152	0.114
1988	275	440	497	661	1,873	Crit	Ok	Check	Check	Check	0.147	0.235	0.265	0.353
1989	43	16	60	16	135	Crit	Check	Check	Check	Check	0.319	0.119	0.444	0.119
1990	2	90	42	8	142	Crit	Check	Check	Check	Check	0.014	0.634	0.296	0.056
1991	30	69	102	250	451	Crit	Check	Check	Check	Check	0.067	0.153	0.226	0.554
1992	90	123	617	655	1,485	Crit	Check	Check	Check	Check	0.061	0.083	0.415	0.441
1993	72	69	105	105	351	Crit	Check	Check	Check	Check	0.205	0.197	0.299	0.299
1994	105	370	263	225	963	Crit	Check	Check	Check	Check	0.109	0.384	0.273	0.234
1995	79	476	825	2,787	4,167	Crit	Check	Check	Ok	Ok	0.019	0.114	0.198	0.669
1996	100	774	2,650	6,976	10,500	Crit	Check	Check	Ok	Ok	0.010	0.074	0.252	0.664
1997	26	104	475	47	652	Crit	Check	Check	Check	Check	0.040	0.160	0.729	0.072
1998	24	143	226	336	729	Crit	Check	Check	Check	Check	0.033	0.196	0.310	0.461
						Crit								
						Crit								
						Above								
						Crit								
						Above								
						Crit								
						Crit								
						Crit								
										74-98 Mean	0.109	0.311	0.292	0.288
										74-80 Mean	0.069	0.392	0.263	0.277
										SD	0.026	0.199	0.083	0.130
										EDF	0.043	0.193	0.180	0.147
										MEF	182	1,042	700	736

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